**TRW Automotive**

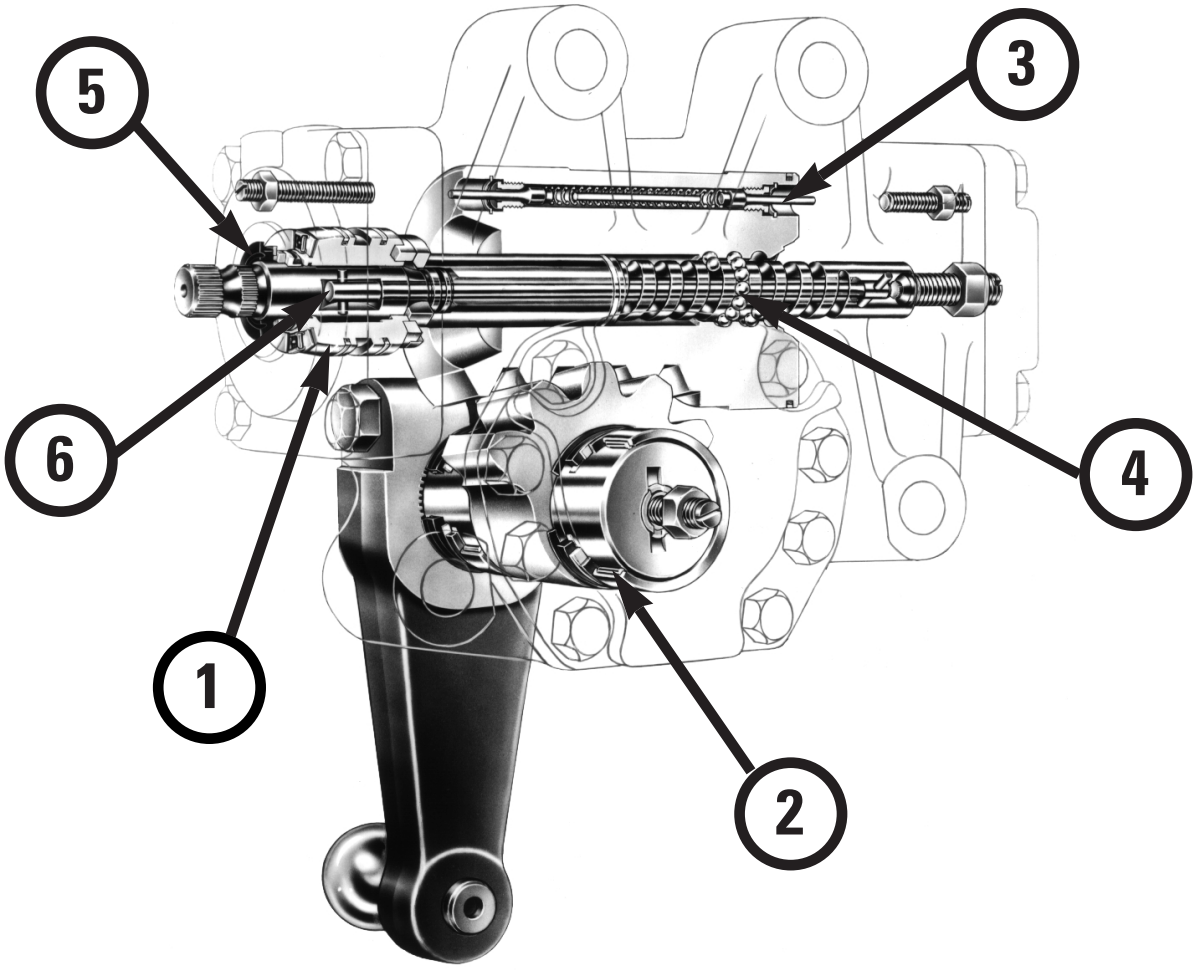
Commercial Steering Systems

# HFB Steering Gear Service Manual

HFB70 SERIES

# HFB70 Integral Hydraulic Power Steering Gear

This steering gear was specifically designed for motor trucks; new design features and our design experience with previous models of integral hydraulic power steering gears have been combined into this new product.




## Design Features

1. **Rotary Valve** - This device provides responsive steering control
2. **Precision Roller Bearings** - Allow the steering gear to operate with high efficiency and reversibility
3. **Unloading Valves** - Furnish power steering pump protection and reduce pressure to unload steering linkage at the ends of steering gear travel
4. **Recirculating Balls** - Combines high mechanical efficiency with smooth operation
5. **Dirt and Water Seals** - Lip type seals on both input and output shafts
6. **Torsion Bar** - Provides positive valve centering with definitive "feel of the road"

- Balanced Area Cylinder - Back pressures cannot affect steering stability
- High Temperature Seals - These specially developed seals may be operated intermittently at 300°F (148.9°C)
- Manual Steering Capability - Provides for steering control in the event of hydraulic failure
- Compactness - Lowest weight to output torque ratio in the industry
- Auxiliary Porting Available - For auxiliary cylinder control
- Seal Protectors - Provide protection from harsh environment

# Definitions

**NOTE:** **A NOTE gives key information to make procedures easier or clearer.**

**CAUTION:** **A CAUTION refers to those procedures which must be followed to avoid damage to the gear.**

**WARNING:** **A WARNING REFERS TO THOSE PROCEDURES WHICH MUST BE FOLLOWED FOR THE SAFETY OF THE DRIVER AND THE PERSON INSPECTING OR REPAIRING THE GEAR.**

# Disclaimer

This Service Manual has been prepared by TRW Ross Gear Division for reference and use by mechanics who have been trained to repair and service steering components and systems on heavy commercial vehicles. TRW Ross Gear Division has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the techniques and tools required for maintaining, repairing and servicing the complete line of TRW Ross Gear HFB70 Integral Power Steering Gears. However, despite the care and effort taken in preparing this general Service Manual, TRW makes no warranties that (a) the Service Manual or any explanations, illustrations, information, techniques or tools described herein are either accurate, complete or correct as applied to a specific HFB70 steering gear, or (b) any repairs or service of a particular HFB70 steering gear will result in a properly functioning steering gear.

If inspection or testing reveals evidence of abnormal wear or damage to the HFB70 steering gear or if you encounter circumstances not covered in the Manual, STOP - CONSULT THE VEHICLE MANUFACTURER'S SERVICE MANUAL AND WARRANTY. DO NOT TRY TO REPAIR OR SERVICE AN HFB70 STEERING GEAR WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL TRW REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO TRW'S SPECIFICATIONS FOR THE HFB70 STEERING GEAR.

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular HFB70 steering gear to (a) inspect the steering gear for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the vehicle, or the safe operation of the vehicle, and (c) fully inspect and test the HFB70 steering gear and the vehicle steering system to insure that the repair or service of the steering gear has been properly performed and that the steering gear and system will function properly.

This TRW Ross Gear Division vehicle power steering gear is covered by one or more of United States patent numbers: 3,896,702; 3,606,819; 3,741,074; 3,773,081; 3,955,473; 3,935,790; and 3,921,669. Other United States patent applications are pending, and corresponding foreign patents are pending and issued.

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**WARNING: ALL STEERING MECHANISMS ARE LIFE AND LIMB ITEMS. AS SUCH, IT IS IMPERATIVE THAT THE INSTRUCTIONS IN THIS BOOKLET ARE FOLLOWED TO THE LETTER. FAILURE TO OBSERVE THE PROCEDURES SET OUT IN THIS PAMPHLET MAY RESULT IN LOSS OF STEERING.**

# Introduction

## Service Manual for Model HFB70

This service manual has one purpose: to guide you in maintaining, troubleshooting and servicing the HFB70 Hydrapower ™ integral power steering gear.

Material in this manual is organized so you can work on the HFB70 and get results without wasting time or being confused. To get these results, you should review the contents of this manual before you begin any work on the HFB70.

The section of this manual on General Design and Operation, treats the major parts of the HFB70 and explains how they function together. The knowledge you acquire from reviewing this section should assist you in solving your steering problem.

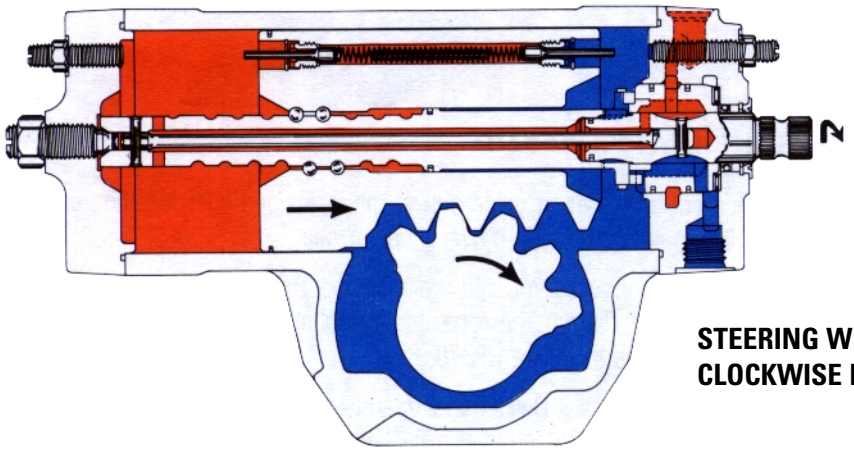
This manual also contains troubleshooting information and checklists. With them, you can diagnose a steering problem without removing the HFB70 from the vehicle. If you must service the HFB70 the checklists will help you to determine where the problem may be.

The three-column format of the Repairs, Adjustments, Disassembly, Inspection and Assembly sections will make it easier for you to service the HFB70. Column 1 gives a brief key for each procedure. Column 2 explains in detail the procedure you should follow. Column 3 illustrates this procedure with photographs. Pay special attention to the notes, cautions, and warnings.

A foldout page with the same typical HFB70 exploded assembly view on both sides is provided in this manual. The component part names and item numbers assigned on this exploded assembly view correspond with names and item numbers (in parentheses) used in the disassembly, assembly and other procedures set forth in this manual. When this exploded assembly view page is folded out, you can easily identify components and locate their relative position on the exploded assembly view as you follow the disassembly, assembly and other procedures.

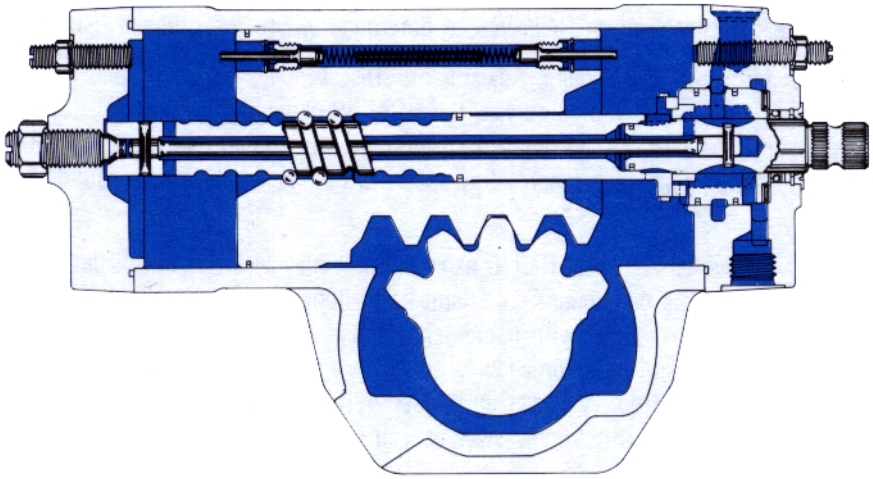
As you gain experience in servicing the HFB70, you may find that some information in this manual could be clearer and more complete. If so, let us know about it. Don't try to second guess the manual; if you are stuck, contact us. Servicing the HFB70 should be a safe and productive procedure.

# HFB70 OIL FLOW ILLUSTRATION

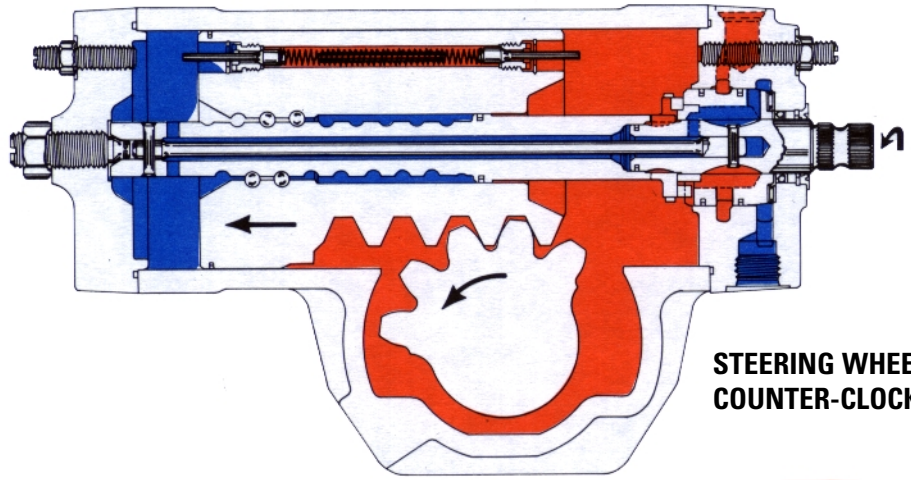



STEERING WHEEL INPUT
CLOCKWISE ROTATION

Right Hand Turn



Neutral - No Steering Action




STEERING WHEEL INPUT
COUNTER-CLOCKWISE ROTATION

Left Hand Turn

Supply Pressure

Return Pressure

# HFB70: General Design and Operation

## Design

### Integral Power Steering

The HFB70 power steering gear is the latest design in the Ross family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear box contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

### Rotary Control Valve

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute-gpm or Liters/Min.) directed to a cylinder cavity.

The pressure (measured in pounds per square inch—psi or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the cylinder cavity at the proper flow rate and pressure.

### Pressure Means Work, Flow Means Speed

The higher pressure a gear can withstand, the more work it can perform. The HFB70 can steer a vehicle with a front end weight rating of about 16,000 pounds (7257 Kg) through a turn at low vehicle speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear in one minute. For the HFB70, maximum operating pressure is 2000 psi (137.9 bar), maximum flow rate 8 gpm (30 Liters/Min). NOTE: The recommended minimum flow at 1 1/2 hand wheel turns/second must be no less than 3.4 gpm (13 Liters/Min.). If the HFB70 steering gear is controlling an auxiliary cylinder, increased minimum flow is required based on the size of the auxiliary cylinder and the vehicle's steering geometry.

## Operation

### What Happens During a Steering Maneuver

When the driver turns the steering wheel, he transmits force from the wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

### Shock Loads to the Gear

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft, to the rack piston, and onto the worm shaft. The internal geometry of the steering gear causes the control valve to send high pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

### Unloading (Poppet) Valves

The HFB70 gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage.

### Bleed Systems

Some HFB70 gears which are mounted with the output shaft above the rack piston bore are equipped with a manual bleed screw.

The procedure for servicing the manual bleed screw is described under "Filling and Air Bleeding" (page 50) in this manual.

# Troubleshooting Information

## Preliminary Checks

When a customer comes to you with a problem related to his truck's steering, you can save a lot of time and work if you first verify the problem. Make sure you're both talking the same language about the same problem. If he says the truck's hard to steer, find out exactly what he means. Is it hard steering into a right or left turn? Only when turning the steering wheel while the truck is sitting still? Is there only intermittent power steering? Or is there no power assist at all?

If at all possible, and if it's safe to do so, test drive the truck. If you're not familiar with the rig, let the customer drive it while you sit beside him. Take hold of the wheel while he drives to get a feel for the problem he's talking about. Since most of his driving will be with his truck hauling a load, arrange for a load if one is required to reproduce the steering problem.

**Typical Steering System**

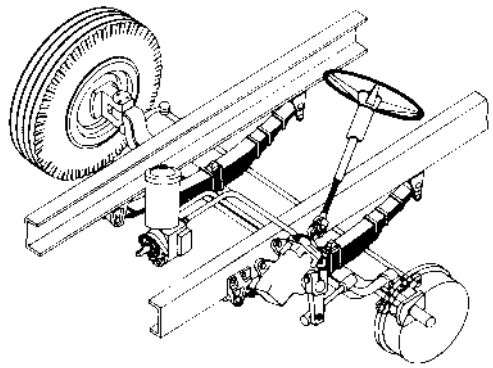


Figure 1

**Typical Steering System (with Auxiliary Cylinder)**

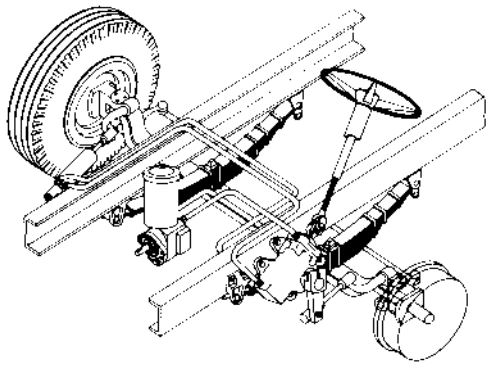


Figure 1A

Once you've determined the problem and its symptoms, don't jump right in to tear the steering gear or pump apart.
In most cases, in fact, the gear should be the last component you check. There are many other components in the steering system that could be causing the problem (see FIG. 1 & 1A). These you should check first.

Begin, then, by checking the steered wheels: make sure that the tires are at correct pressure and equal all around, that they are properly sized, and that they are not worn or damaged.

Next, have the front-end alignment checked and look for abnormal looseness or tightness in the steering linkage, ball joints, and king pins.

A service replacement hose or fluid line may be misrouted or may be too small in diameter, or it may be restricted in some ether way. Reroute any hose that is kinked or bent sharply. Replace any hoses that are not the same as original equipment.

Continue by checking the power steering fluid reservoir to make sure that oil is up to the correct level. Also, check the pump drive belt, if one is used, to see if it is slipping. The belt may be tight, but it may also be glazed, and a slipping belt doesn't always squeal. If you adjust the belt, check the specifications.

These are just some of the checks you should make before you turn to the steering gear or pump. The Troubleshooting Guide on pages 8 thru 10 explains what to diagnose for a particular steering problem. Match the trouble symptom against the chart and follow the recommended troubleshooting sequence. Doing so will most likely save you time and may prevent unnecessary repairs and costs.

## Hydraulic Tests

If the checks described above all prove satisfactory, it is possible that the cause of the steering problem can be traced to a lack of pressure or insufficient flow. In this case, you may have to do more detailed troubleshooting that involves conducting hydraulic tests.

## Preparation for Hydraulic Tests

To conduct the following hydraulic tests, first install a flow meter, pressure gage and load (shut off) valve in the fluid supply line to the steering gear, as indicated by the instructions that come with the flow meter. Steering system analyzers are available with the 3 units integral. Place a thermometer in the reservoir (FIG. 2) You must use a flow meter, and it is recommended that you use a thermometer, if you are to troubleshoot the hydraulic system accurately. Start the engine and warm the hydraulic system up by partially closing the load valve until the pressure gage reads 1000 psi (69.0 Bar). When the fluid temperature, as indicated on the thermometer, reaches between 125°F (51.7°C) and 135°F (57 2°C), open the load valve. The system is warmed up, and you can conduct the tests.

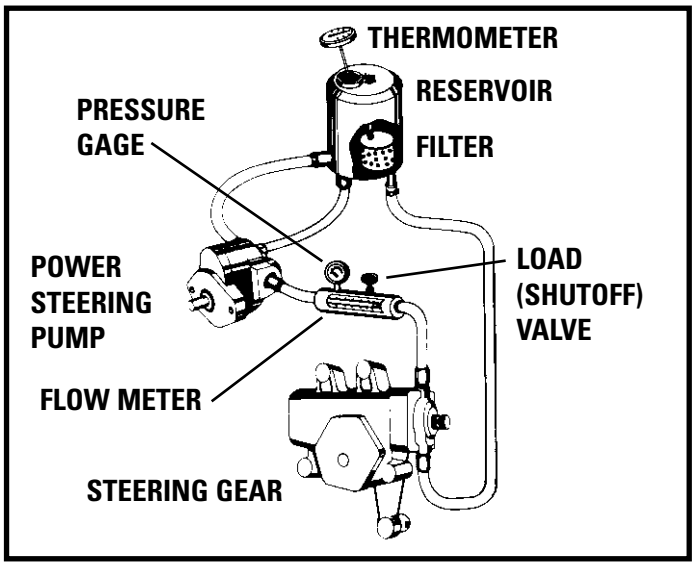



Figure 2

**CAUTION: Do not close the load valve completely and leave it closed, or you may damage the pump. At no time allow fluid temperature to exceed 180°F (82.2°C). Run all the tests at the prescribed temperature range of 125°F (51.7°C) 135°F (57.2°C).**

## Power Steering Pump Pressure Test

With the engine idling, close the load valve and read the pressure gage. If the pressure reads below the minimum specified by the pump manufacturer, repair or replace the pump.

**CAUTION: Do not keep the load valve closed for longer than 5 seconds to avoid damaging the pump. Closing the load valve causes the pump to operate at relief pressure and the fluid temperature to increase rapidly. Allow fluid to cool between 125°F (51.7°C) and 135°F (57.2°C) before you resume with the other tests.**

## Power Steering Pump Flow Test

**WARNING: MAXIMUM FLOW RATE FOR THE HFB70 STEERING GEAR IS 8 GPM (30 LITER/MIN). FLOW RATE SHOULD NOT EXCEED 8 GPM (30 LITER/MIN). EXCESSIVE FLOW CAN CAUSE DAMAGE TO INTERNAL PARTS OF THE STEERING GEAR, WHICH COULD RESULT IN A LOSS OF POWER STEERING.**

**NOTE: If flow specifications and methods of checking flow rate are provided by the vehicle manufacturer, you should follow those instructions rather than the procedure described below.**

With the engine idling and the fluid temperature between 125°F (51.7°C) and 135°F (57.2°C), check the pump manufacturer's specifications for flow rate. Compare these specifications with the flow rate on the flow meter.

Now, fully close the load valve until the pressure gage registers the pressure at which the pump is relieving. When pump relief is reached, flow rate must be zero. IMMEDIATELY OPEN THE LOAD VALVE. The flow rate must instantly return to the original reading. If this rate does not return immediately, the pump is malfunctioning, which can result in intermittent power assist.

Now, set the engine at governed rpm, and fully close the load valve again until pump relief is reached. At pump relief, the flow rate must be zero. IMMEDIATELY OPEN THE LOAD VALVE. The flow rate must instantly return to the original reading. If this rate does not return immediately, the pump is malfunctioning, which can result in intermittent power assist.

**NOTE: Conduct the pump flow test once at idle rpm and three times at governed rpm.**

**CAUTION: Do not allow the fluid temperature to exceed 180°F (82.2°C). Run each phase of this test between 125°F (51.7°C) and 135°F (57.2°C).**

## Steering Gear Internal Leakage Test

To test the steering gear for internal leakage, you must first prevent operation of the gear's internal unloading (poppet) valves. This will allow full pump relief pressure to develop. To prevent operation of the poppets, place an unhardened steel spacer block, about 1 inch thick and long enough to keep your fingers clear, between the axle and stop at one wheel (see FIG. 3)

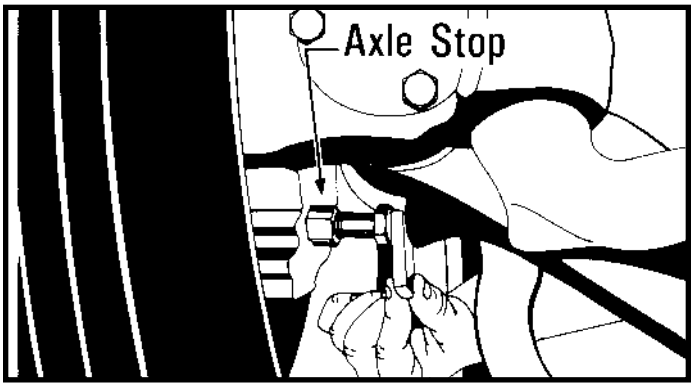



Figure 3

With the fluid temperature between 125°F (51 7°C) and 135°F (57.2°C), turn the steering wheel until the axle stops bottom on the spacer block (FIG. 3).

**CAUTION: When running this test, do not hold the steering wheel in the full turn position for longer than 5 to 10 seconds at a time to avoid damaging the pump.**

**WARNING: KEEP YOUR FINGERS CLEAR OF THE AXLE STOPS AND SPACER BLOCK DURING THIS TEST. MAKE SURE THAT THE SPACER BLOCK CONTACTS THE AXLE STOP SQUARELY. CONTACT THAT IS NOT SQUARE COULD BREAK THE AXLE STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.**

Apply 20 lbs. (9.1 KG) to the rim of the steering wheel during this test to be sure that the steering gear control valve is fully closed. The pressure gage should now read pump relief pressure, as noted during the pump pressure test. You can now read steering gear internal leakage on the flow meter.

Acceptable internal leakage can range from 0 to 1.5 gpm. (5.7 Liters/Min.)

Repeat this test for the opposite direction of turn.

If internal leakage is greater than 1.0 gpm (3.8 Liters/ Min.) and there is no auxiliary hydraulic cylinder in the system, repair the gear. If the internal leakage is greater than 1.5 gpm (5.7 Liters/Min.) and there is an auxiliary hydraulic cylinder in the system, controlled by the HFB70 gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic lines at the HFB70 unit's auxiliary ports. Plug those ports with suitable pressure plugs or caps. Connect the disconnected lines together if a rotary auxiliary cylinder is in the system. Plug the disconnected lines if a linear auxiliary cylinder is in the system and disconnect the linear cylinder from the steering linkage, making sure it will clear the steered axle. Repeat the internal leakage test. If the internal leakage is less than 1.0 gpm (3.8 Liters/Min.), repair the auxiliary cylinder. If the internal leakage is greater than 1.0 gpm (3.8 Liters/Min.), repair the HFB70 gear. See internal leakage diagram, FIGURE 4.

**NOTE: When hydraulic tests are completed and fluid lines are reconnected, check fluid level and air bleed the system. Reference page 50.**

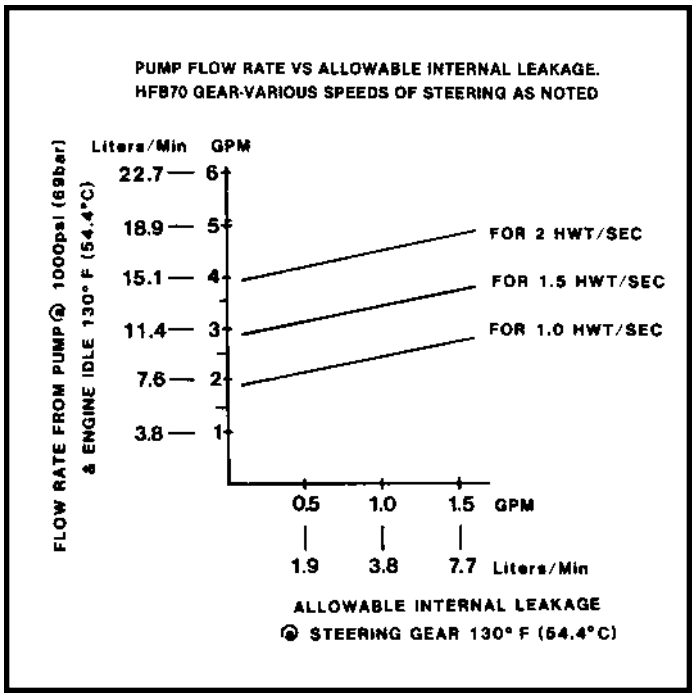



Figure 4

**NOTE: If all seals as included in the complete seal kit have been correctly replaced, and the HFB70 steering gear cannot pass the internal leakage test, or if intermittent loss of power steering occurs, a service worm shaft/input shaft, valve sleeve assembly is required.**

# Troubleshooting Guide

## I. Normal Noises

- You or the driver may hear a "hissing" noise from the control valve when it is actuated during a steering maneuver.
- You or the driver may hear a noise as fluid bypasses through the poppets at full turn.
- You or the driver may hear a noise from the system relief valve when it is required to actuate.
- You or the driver may hear pump "growl" from some types of power steering pumps.

## II. Abnormal Noises

- If the power steering pump is belt driven, a "squealing" noise may indicate that the belts should be tightened or replaced.
- A "clicking" noise heard during a turn, or when changing directions, may indicate that some component is loose and shifting under load.
- A change in the normal noise of the pump may indicate that air has been induced into the system or that fluid level is low.

# III. Possible Steering Problems and Causes

## Road Wander

- Tire pressure incorrect or unequal left to right.
- Components in steering linkage loose or worn (Steering wheel to road wheel).
- Wheel bearings improperly adjusted or worn.
- Front end alignment out of specification.
- Dry fifth wheel or poor finish on fifth wheel or trailer plate.
- Steering gear mounting bolts loose on frame.
- Steering gear improperly adjusted.
- Looseness in rear axle assemblies or trailer bogies.

## No Recovery

- Tire pressure low.
- Front end components binding.
- Front end alignment incorrect.
- Tight front axle king pins.
- Dry fifth wheel or poor finish on fifth wheel or trailer plate.
- Steering column binding.
- Pump flow insufficient.
- Steering gear improperly adjusted.
- Steering gear control valve sleeve sticking.

## Shimmy

- Badly worn or unevenly worn tires.
- Improperly mounted tire or wheel.
- Wheel bearings improperly adjusted or worn.
- Components in steering linkage loose or worn.
- Wheels or brake drums out of balance.
- Front end alignment incorrect.
- Air in the hydraulic system.

## External Oil Leakage

- Finding the location of leak may be difficult, since oil may run away from leak source, the fittings, hoses, pump, or gear to a low point on the gear or chassis.
- A leak from the vent plug at the side cover indicates failure of the sector shaft oil seal inside the side cover.

## Oversteering or Darting

- Dry fifth wheel or poor finish on fifth wheel or trailer plate.
- Front end components binding or loose.
- Steering column binding.

- Steering gear improperly adjusted.
- Steering gear control valve sleeve sticking.
- Rear axle mounts (rear steer).

### High Steering Effort in One Direction

- Unequal tire pressure.
- Vehicle overloaded.
- Inadequate hydraulic system pressure.
- Excessive internal leakage in one direction of turn only (verify with internal leakage test).

### High Steering Effort in Both Directions

- Low tire pressure.
- Vehicle overloaded.
- Low hydraulic fluid level.
- Low pressure or flow from pump.
- Components of steering system binding.
- Restriction in return line, or line too small in diameter.
- Excessive internal leakage (verify with internal leakage test).
- Oversize tires (check manufacturer's specifications).

### Lost Motion (Lash) at the Steering Wheel

- Steering wheel loose on the shaft.
- Loose connection between the steering gear, intermediate column, and steering column.
- Steering gear loose on frame.
- Pitman arm loose on output shaft.
- Components in steering linkage loose or worn.
- Steering gear improperly adjusted.

### Excessive Heat [150°F (65.6°C) Over Ambient]. Not to Exceed 250°F (121°C) Continuously

- Excessive pump flow.
- Vehicle overloaded.
- Undersized replacement hose or line.
- Restricted hose or line that is kinked or severely bent or internally blocked.
- Restricted recentering of gear valve caused by column bind or side load on the input shaft.
- Poppet not adjusted properly (only for gears equipped with poppets).
- Prolonged stationary vehicle operation.

**WARNING: IF THE HYDRAULIC SYSTEM FLUID BECOMES OVERHEATED, IT CAN CAUSE THE SEALS IN THE STEERING GEAR AND PUMP TO SHRINK, HARDEN, OR CRACK AND LOSE THEIR SEALING ABILITY.**

# Repairs and Adjustments on Vehicle

When you have conducted the checks and tests described in the troubleshooting sections, you may find it necessary to repair or adjust the steering gear. Since removing the gear from the vehicle is usually difficult and time-consuming, you will probably find it easier to perform the following repairs and adjustments with the gear on the vehicle. The photographs in this section show a gear mounted on a mock-up frame for clearer illustration.

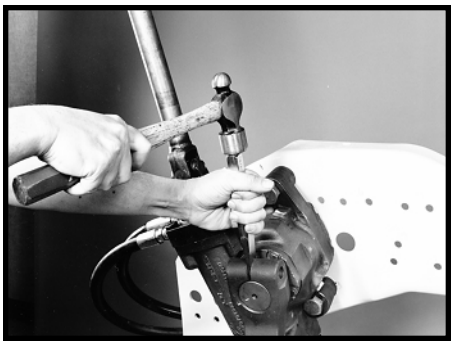


Figure 5

## 1 The Sector Shaft And Trunnion Cover

**remove pitman arm**

1.1 If a leak is detected in the trunnion cover area on many HFB70 installations, you can remove the trunnion cover to gain access to the sector shaft seal package while the steering gear is on the vehicle. First remove the pitman arm nut and bolt and then the pitman arm from the sector shaft (48). SEE FIGURES 5 & 6. Check the radial position of the pitman arm to the sector shaft prior to removal of pitman arm. Add timing marks to the arm and shaft if necessary to insure correct alignment at reassembly.

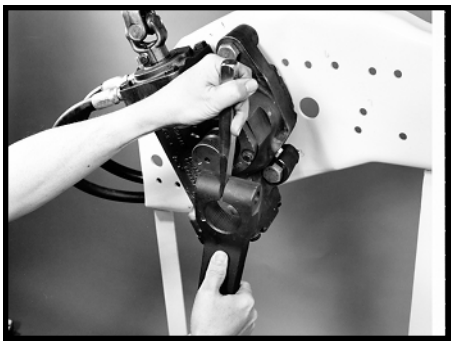


Figure 6

**NOTE**

**NOTE: A chisel will help you loosen the pitman arm. Use only a puller if you cannot remove the pitman arm with your hands.**

Figure 7

**WARNING**

**WARNING: WHEN USING A CHISEL TO SPREAD THE PITMAN ARM BOSS IN ORDER TO LOOSEN THE PITMAN ARM FOR REMOVAL FROM THE SHAFT, MAINTAIN A FIRM GRIP ON THE CHISEL AT ALL TIMES. FAILURE TO DO THIS MAY RESULT IN THE CHISEL FLYING LOOSE WHICH COULD CAUSE AN INJURY. NEVER LEAVE THE CHISEL WEDGED IN THE PITMAN ARM BOSS. IF YOU CANNOT REMOVE THE PITMAN ARM FROM THE SHAFT WITH A CHISEL AND YOUR HANDS, REMOVE THE CHISEL FROM THE PITMAN ARM AND USE A PULLER ONLY TO REMOVE THE PITMAN ARM.**

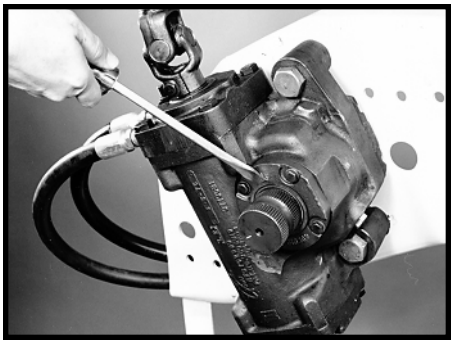


Figure 8

**remove protector boot, fitting and dirt and water seal**

1.2 Remove protector boot (60), grease fitting (61) and dirt and water seal (26). SEE FIGURE 7, 8. Discard protector boot and dirt and water seal.

**clean sector shaft**

1.3 Clean the sector shaft (48) with a fine grade of emery paper. Be sure to remove any paint. SEE FIGURE 9.

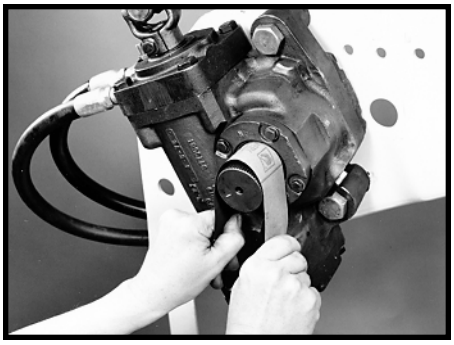


Figure 9

**remove trunnion cover & seal package**

1.4 Next, remove the four trunnion cover bolts (28) washers (27) and trunnion cover (25). SEE FIGURE 10. A 1/2 inch socket required. Be prepared for fluid loss. Then remove and discard the sector shaft seal package consisting of the two-piece sector shaft seal (23), the Teflon* backup washer (24), and the trunnion cover seal ring (22). SEE FIGURE 11.

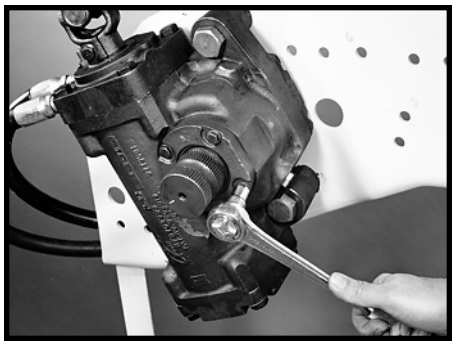


Figure 10

**clean and inspect trunnion cover**

1.5 Clean the trunnion cover (25) with petroleum based solvent, blow dry and inspect the seal cavity and sealing face for nicks or corrosion. Replace the trunnion cover with a new one if these conditions exist.

**WARNING**

**WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.**

**WARNING**

**WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.**

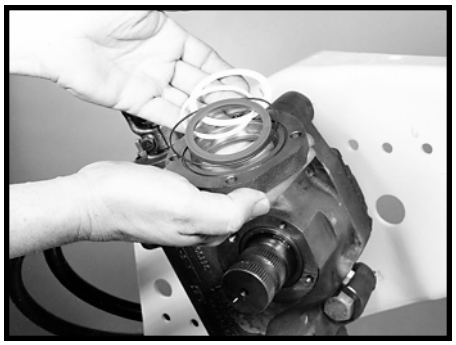


Figure 11

**install new washer**

1.6 Place the trunnion cover (25) on a bench to install the new seal package. Start with the new Teflon backup washer (24).

**install new seal**

1.7 Install the new two-piece sector shaft seal (23), so that the words "oil side" are visible after seal is in place. SEE FIGURE 12.

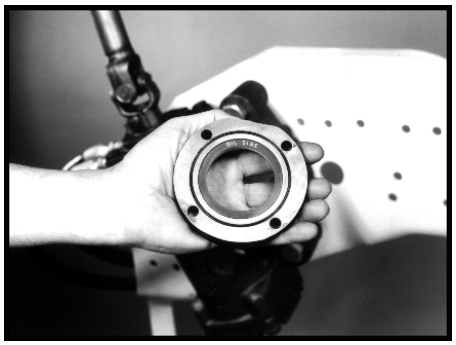


Figure 12

**WARNING**

**WARNING: THE WORDS "OIL SIDE" MUST BE VISIBLE ON THE SEAL AFTER IT IS IN PLACE. IF NOT, THE SEAL WILL NOT FUNCTION, AND A LOSS OF POWER STEERING ASSIST MAY OCCUR.**

**install new seal ring**

1.8 Grease the new trunnion cover seal ring (22) and install it into the cover groove.

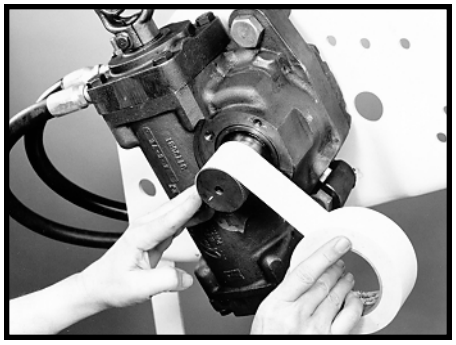


Figure 13

**tape sector shaft**

1.9 Cover the serrations of the sector shaft (48) with tape to avoid damaging the seals during installation. SEE FIGURE 13.

**NOTE**

**NOTE: Use only one layer of tape.**

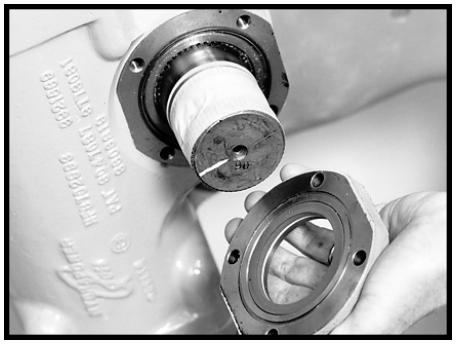


Figure 14

*Teflon is a registered trademark of DuPont Corporation

**install trunnion cover, washers & bolts**

1.10 Install the trunnion cover (25) and four trunnion cover washers (27) and bolts (28). Torque bolts to 15-22 ft. lbs. (20-30 N m) if dry or 11-16 ft. lbs. (15-22 N m) if lubricated. 1/2 inch socket required. SEE FIGURES 14, 15, 16.

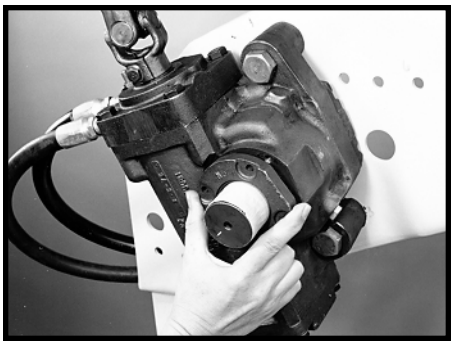


Figure 15

**install new dirt & water seal**

1.11 Pack clean high temperature industrial grease per Ross specification 045231, *Mobil temp. 1 or 2 or equivalent around seal area of sector shaft (48). Install a new dirt and water seal (26) using a suitable blunt end drift. SEE FIGURE 17.

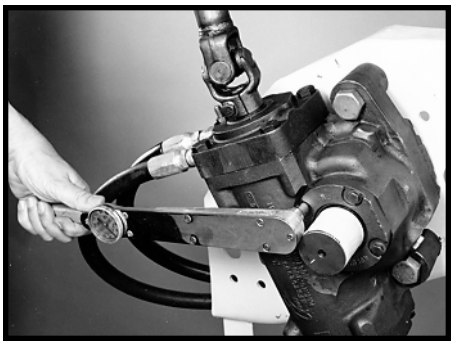


Figure 16

**assemble protector boot & fitting**

1.12 Apply a generous amount of the same grease to protector boot (60) in the area inside of the smaller diameter ring. Assemble protector boot onto sector shaft (48) and trunnion cover (25), locating the grease fitting hole toward the input shaft end of gear assembly. Insert grease fitting (61) into protector boot. Remove tape from sector shaft serrations. SEE FIGURE 18.

Figure 17

**install pitman arm**

1.13 Reconnect the pitman arm, making sure the timing mark on the pitman arm aligns with the timing mark on the sector shaft. SEE FIGURE 19.

Figure 18

**WARNING**

**WARNING: WHEN USING A CHISEL TO SPREAD THE PITMAN ARM BOSS FOR ASSEMBLY ONTO THE SECTOR SHAFT (48), MAINTAIN A FIRM GRIP ON THE CHISEL AT ALL TIMES. FAILURE TO DO THIS MAY RESULT IN THE CHISEL FLYING LOOSE WHICH COULD CAUSE AN INJURY. NEVER LEAVE THE CHISEL WEDGED IN THE PITMAN ARM BOSS.**

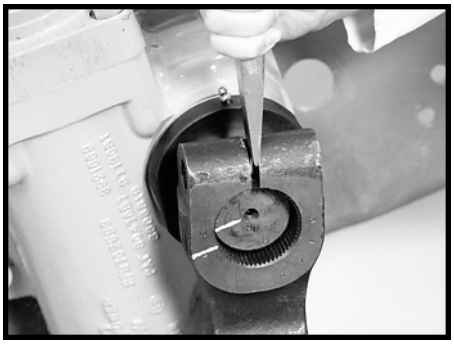


Figure 19

*Mobil Temp is a Registered Trademark of Mobil Oil Co.

**install and torque pitman arm bolt**

1.14 Insert the pitman arm clamp bolt and nut assembly, using a 3/4-16 grade 8 bolt. SEE FIGURE 20. If the bolt is lubricated or plated, torque its to 300-320 ft. lbs. (407-434 N m). If dry and unplated, torque to 380-420 ft. lbs. (515-569 N m).

**CAUTION**

**CAUTION: Be sure there is no spreading wedge left in the pitman arm boss before torquing pitman arm clamp bolt.**

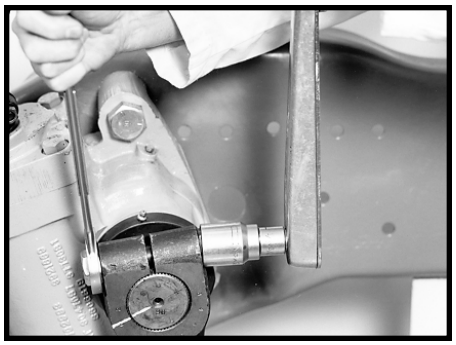


Figure 20

**fill and bleed system**

1.15 Before operating the steering gear, fill the with the recommended fluid and bleed air the system by following the Filling and Air Bleeding instructions on page 50.

Figure 21

## 2 The Worm Shaft/Input Shaft Seal

**remove input coupling & protector, clean input shaft**

2.1 If there is a leak in the shaft seal, you can usually replace the input shaft seal assembly with the gear on the vehicle. Start by removing the input coupling per the vehicle manufacturers instructions. SEE FIGURE 21. Remove seal protector (62) and clean the area around the input shaft with a fine grade of emery paper. SEE FIGURE 22 & 23.

Figure 22

**WARNING**

**WARNING: DO NOT DRIVE OR PRY COUPLING FROM WORM SHAFT/INPUT SHAFT. INTERNAL DAMAGE TO THE STEERING GEAR CAN RESULT. IF COUPLING IS TIGHT, INSERT SCREWDRIVER INTO SLOT TO RELEASE.**

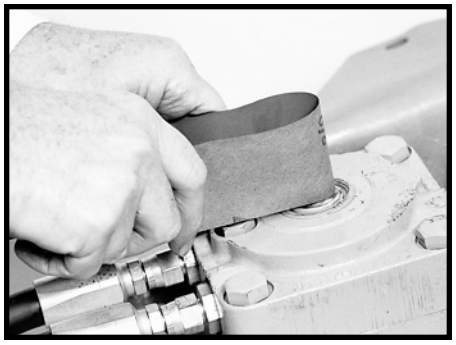


Figure 23

**remove and plug the return line**

2.2 Remove and plug the return line. SEE FIGURE 24.

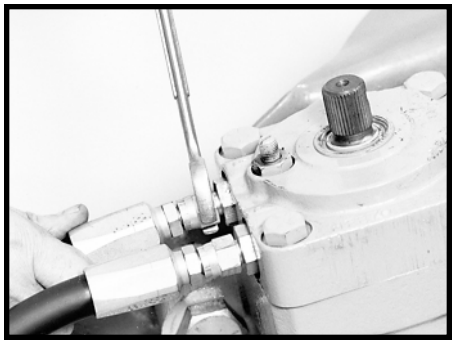


Figure 24

**remove seal**

2.3 Remove and discard the dirt and water seal (4) SEE FIGURE 25.

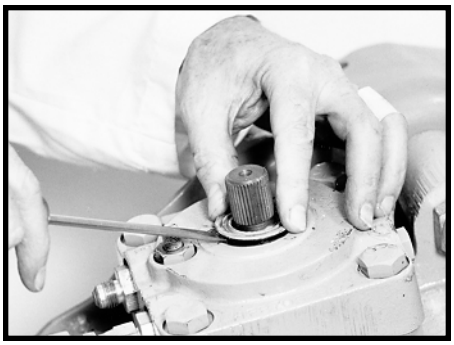


Figure 25

**remove retaining ring**

2.4 Remove the seal retaining ring (5) from the valve housing (8). SEE FIGURE 26.

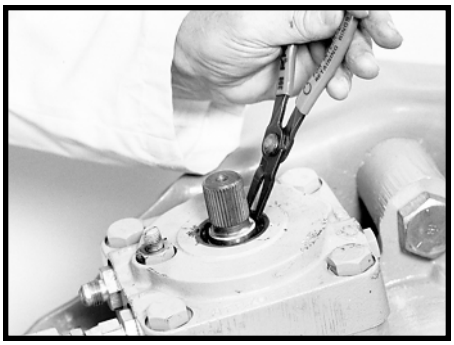


Figure 26

**apply air pressure to port**

2.5 Hold a shop rag over the worm shaft/input shaft and apply shop air pressure to the valve housing (8) return port. SEE FIGURE 27.

**WARNING**

**WARNING: BE SURE TO WEAR EYE PROTECTION, AND TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.**

Figure 27

**remove seal & washer**

2.6 The air pressure will force the two-piece input shaft seal (7) and the steel backup washer (6) to pop out of the gear, and some fluid will squirt out of the gear. SEE FIGURE 28. Discard the seal. Disconnect the shop air as soon as the seal assembly is out.

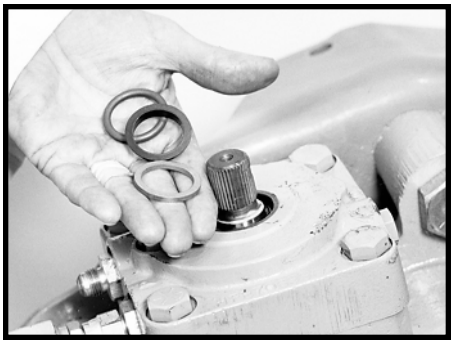


Figure 28

**install seal package**

2.7 Apply clean grease to the new input shaft seal assembly (7), washer (6) and the input shaft. Install the new two piece input shaft seal flat side up and the steel backup washer, using the seal driving tool J28490. SEE FIGURE 29. Install the retaining ring (5).

Figure 29

**grease input shaft**

2.8 Pack the area around the worm shaft/input shaft (16) and dirt and water seal (4) cavity with high temperature industrial grease per Ross specification 045231, *Mobil Temp 1 or 2 or equivalent. SEE FIGURE 30.

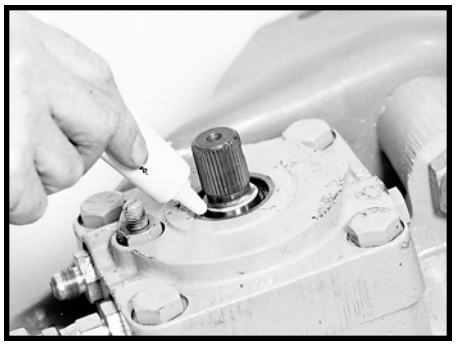


Figure 30

**install seal**

2.9 Install the new dirt and water seal (4) with tool J28490 or a suitable blunt end drift. SEE FIGURE 31.

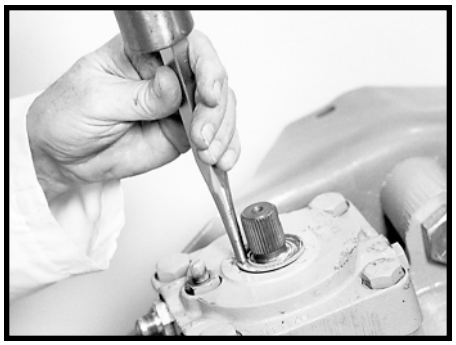


Figure 31

**assemble seal protector**

2.10 Add more grease to seal area and assemble seal protector (62) onto worm shaft/input shaft (16), seating it in the relief groove just beyond the input shaft serrations with cupped side toward the gear. SEE FIGURE 32.

**reconnect line**

2.11 Remove the plug and reconnect the return line.

Figure 32

*Mobil Temp is a Registered Trademark of Mobil Oil Co.

**reconnect input coupling**

2.12 Reconnect the input coupling. If the input coupling male assembly slides free of the female end during reassembly, realign the timing marks to insure proper phasing of the U-joints. Refer to Vehicle Service Manual for proper torque.

**WARNING**

**WARNING: MISTIMED U-JOINTS CAN RESULT IN A BUMPY SENSATION AT THE STEERING WHEEL AND POSSIBLY AFFECT STEERING CONTROL.**

**fill and bleed system**

2.13 Before operating the steering gear, fill the system with the recommended fluid only and bleed the system following the filling and bleeding instructions on page 50.

# Adjustments

You can make three adjustments to the gear while it is mounted on the vehicle: the worm shaft preload adjustment, the poppet valve adjustment and the sector shaft adjustment.

## 3 Worm Shaft Preload Adjustment

(With vehicle engine off)

**loosen sealing nut and adjusting screw**

3.1 Back off the worm shaft adjusting screw sealing nut (39) three turns. SEE FIGURE 33. Back off the worm shaft preload adjusting screw (38) at least one turn. SEE FIGURE 34. Inspect the threads between the jam nut and end cover (37) for foreign matter. Clean the threads or replace the sealing nut if necessary. SEE FIGURE 35.

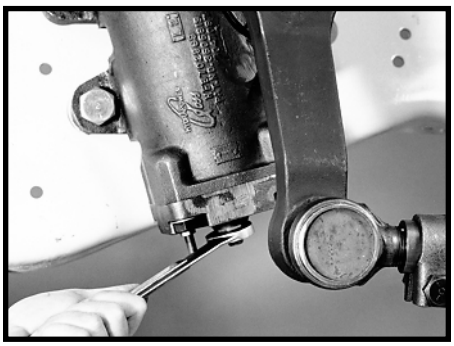


Figure 33

Figure 34

**torque adjusting screw**

3.2 While torquing the worm shaft preload adjusting screw (38) to 60-70 in. lbs. (81-95 N m) have someone lightly move the steering wheel back and forth about one inch (25 mm) total.

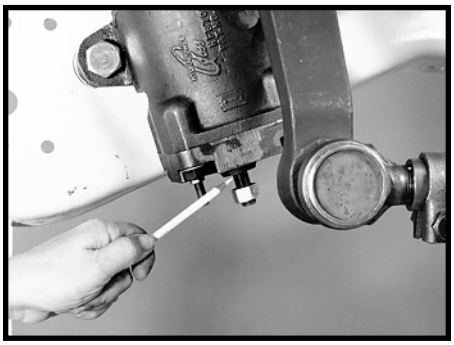


Figure 35

**NOTE**

**NOTE: While torquing the adjusting screw, make sure that the worm shaft adjusting screw sealing nut (39) does not tighten against end cover.**

**torque sealing nut**

3.3 Torque the worm shaft adjusting screw sealing nut (39) to 70-80 ft. lbs. (95-108 N m), making sure that the worm shaft preload adjusting screw (38) does not move. SEE FIGURE 36.

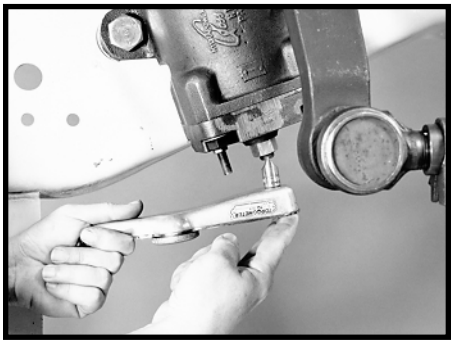


Figure 36

**NOTE**

**NOTE: If the sealing material in the sealing nut has separated, remove the adjusting screw and replace the sealing nut with a new one onto the nonslotted end of the adjusting screw.**

## 4 Poppet Valve Adjustment

(With vehicle engine on)

**set axle stops**

4.1 Before adjustment, properly set the axle stops manufacturer's specifications.

**install flow meter**

4.2 Install a pressure gage/flow meter package in the supply line from the pump to the gear. (Make sure the flow meter can be pressurized.) Bring the fluid temperature up to approximately 130°F, (54°C), using the method described in the troubleshooting section (page 6).

**rotate sector shaft**

4.3 With the engine at idle, have someone turn the steering wheel to full lock, (axle against axle stop) while you observe the rotation of the sector shaft (48). SEE FIGURE 37. If the sector shaft rotates counter clockwise as shown, adjust the poppet adjusting screw identified in FIGURE 37. If the sector shaft rotates clockwise, adjust the other poppet adjusting screw.

**CAUTION**

**CAUTION: If relief pressure is reached while the steering wheel is at full lock (axle against axle stop), release the steering wheel from this position. At no time should relief pressure be maintained for longer than 5 seconds as damage to the pump may result.**

**NOTE**

**NOTE: You must maintain enough force on the steering wheel to assure that the steering gear control valve is completely closed when reading pressure gage.**

**loosen sealing nut and adjusting screw**

4.4 Once you have determined which poppet to adjust and the steering wheel is in full lock (axle stop to axle stop), loosen the poppet adjusting screw sealing nut (2) and the poppet adjusting screw (3 or 42) until the pressure gage reads maximum pump relief pressure. SEE FIGURE 38. 11/16 inch box end wrench and screw driver required.

**set adjusting screw & tighten sealing nut**

4.5 Manually (no power tool) and carefully screw in the poppet adjusting screw (3 or 42) until the pressure gage shows a significant drop in pressure, 200-400 psi (13.8-27.6 Bar) with the steering wheel in full lock. Tighten the poppet adjusting sealing nut (2) to 12-18 ft. lbs. (16-24 N m).

**repeat for other poppet**

4.6 To adjust the other poppet, repeat these instructions for full lock in the other direction. SEE FIGURE 39.

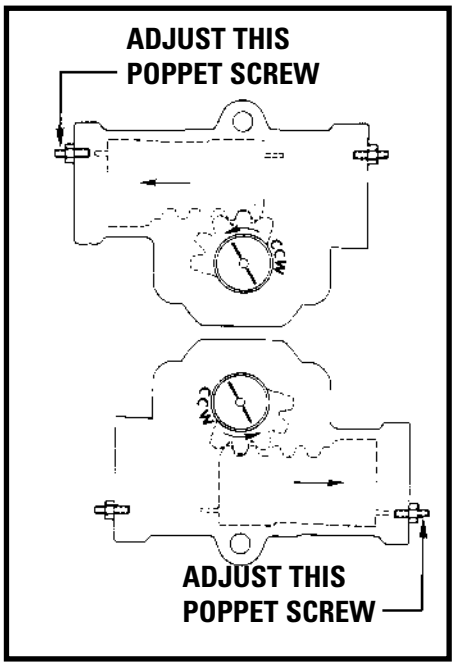



Figure 37

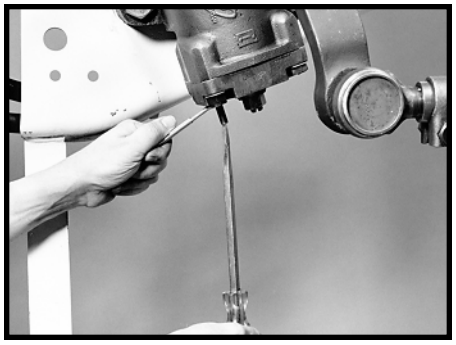


Figure 38

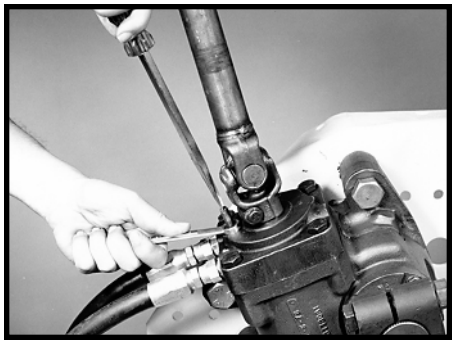


Figure 39

## 5 Cross-shaft or Sector-shaft Adjustment

(With vehicle engine off)

**locate adjusting nut**

5.1 If the sector-shaft adjusting screw jam nut (58), located on the side cover, is not accessible, the steering gear must be removed prior to adjustment.

**remove the drag link**

5.2 If the sector shaft adjusting screw (49) is accessible, remove the drag link from the pitman arm.

**CAUTION**

**CAUTION: This adjustment must be performed with the sector shaft on its center of travel.**

**NOTE**

**NOTE: Because of pitman arm or internal stops or poppet adjustment the "center of travel" for this adjustment may not be the center of sector shaft or handwheel rotation.**

**center the sector shaft**

5.3 To position the sector shaft (48) on center of travel for this adjustment rotate steering wheel (worm shaft/input shaft) until the timing mark across the end of the sector shaft is perpendicular to the worm shaft/ input shaft (16). SEE FIGURE 40, page 20.

**check for lash**

5.4 With the sector shaft (48) in the center position, grasp the pitman arm and gently try to move this arm back and forth in the direction of travel. Finger-tip force is adequate to detect lash of a loose sector shaft. There must be no movement of the input shaft or sector shaft. If no lash is detected, do not adjust.

**position adjusting screw**

5.5 If lash is detected, loosen jam nut (58) with a 3/4 inch socket and move the adjusting screw (49) clockwise until the sector shaft and rack piston (29) are in contact. [Use no more than 10 ft. lbs. (14 N m) of torque]. Then, turn the adjusting screw counterclockwise one turn.

**check for lash**

5.6 At this point, there should be lash at the pitman arm.

**eliminate lash**

5.7 To adjust, slowly turn the adjusting screw (49) clockwise until no lash is felt at the pitman arm. Hold the adjusting screw in place, and tighten the jam nut (58). Final torque 40-45 ft. lbs. (54-61 N m).

**recheck for lash**

5.8 Recheck the pitman arm for lash. Turn the steering wheel 1/4 turn each side of center. No lash should be felt. If lash exists, repeat adjustments 5.3-5.8.

**connect drag link**

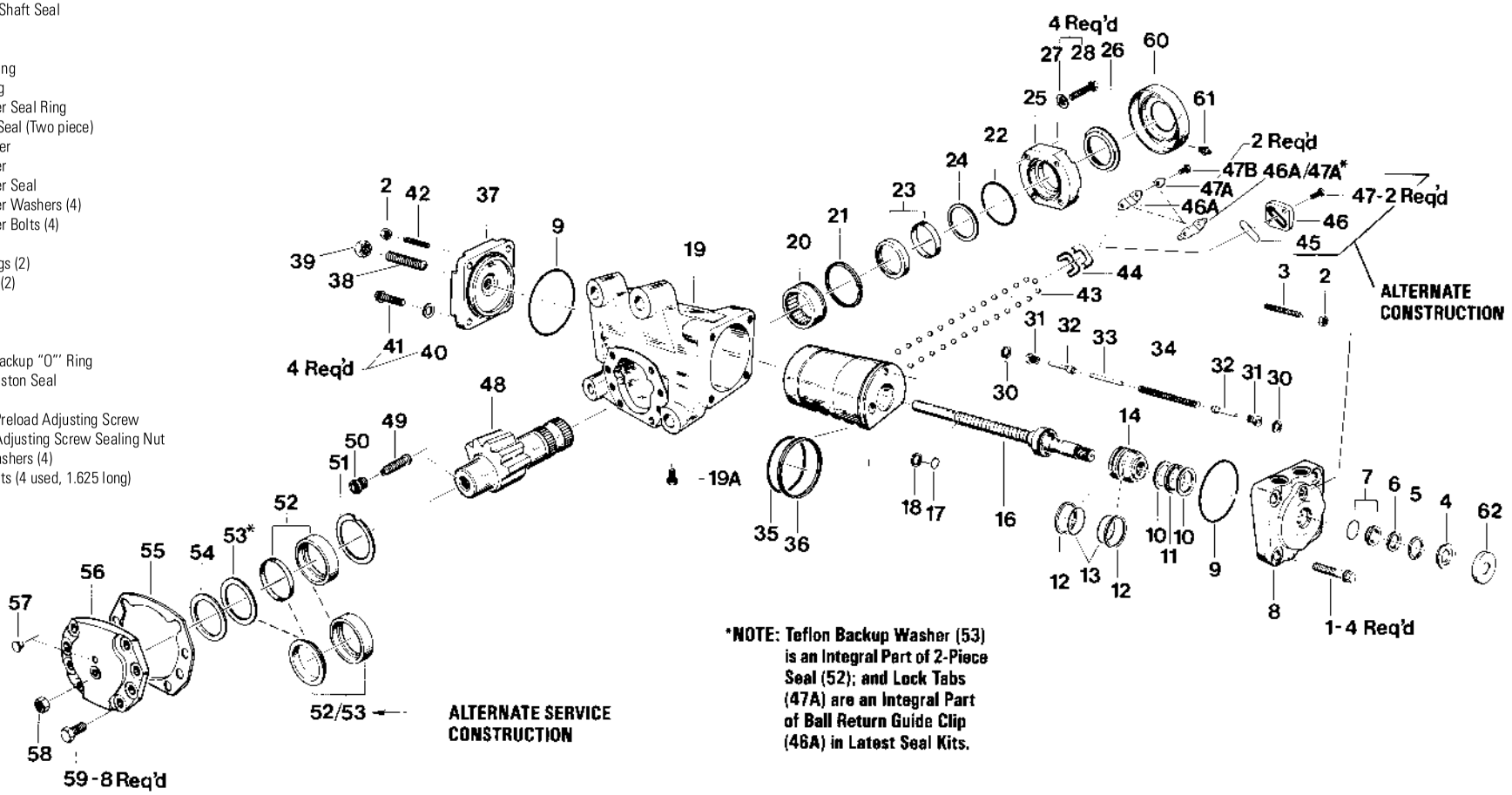
5.9 Re-connect drag link to pitman arm.

# HFB70 Exploded Assembly View - Typical

| ITEM NO. | DESCRIPTION |
|---|---|
| 1. | Valve Housing Bolts (4 used, 2.125 long) |
| 2. | Poppet Screw Sealing Nuts (2) |
| 3. | Poppet Adjusting Screw |
| 4. | Dirt and Water Seal |
| 5. | Retaining Ring |
| 6. | Steel Backup Washer |
| 7. | Input Shaft Seal (Two piece) |
| 8. | Valve Housing |
| 9. | End Cover and Valve Housing Seal Rings |
| 10. | Trust Washer (2) |
| 11. | Thrust Bearing |
| 12. | Teflon Seal Rings (2) |
| 13. | Backup "O" Rings (2) |
| 14. | Valve Sleeve |
| 16. | Worm Shaft/Input Shaft |
| 17. | Worm Shaft Backup "O" Ring |
| 18. | Teflon Worm Shaft Seal |
| 19. | Housing |
| 19A. | Bleed Screw |
| 20. | Housing Bearing |
| 21. | Retaining Ring |
| 22. | Trunnion Cover Seal Ring |
| 23. | Sector Shaft Seal (Two piece) |
| 24. | Backup Washer |
| 25. | Trunnion Cover |
| 26. | Dirt and Water Seal |
| 27. | Trunnion Cover Washers (4) |
| 28. | Trunnion Cover Bolts (4) |
| 29. | Rack Piston |
| 30. | Retaining Rings (2) |
| 31. | Poppet Seats (2) |
| 32. | Poppets (2) |
| 33. | Spacer Rod |
| 34. | Spring |
| 35. | Rack Piston Backup "O"' Ring |
| 36. | Teflon Rack Piston Seal |
| 37. | End Cover |
| 38. | Worm Shaft Preload Adjusting Screw |
| 39. | Worm Shaft Adjusting Screw Sealing Nut |
| 40. | End Cover Washers (4) |
| 41. | End Cover Bolts (4 used, 1.625 long) |

| ITEM NO. | DESCRIPTION |
|---|---|
| 42. | Poppet Adjusting Screw |
| 43. | Balls (34) |
| 44. | Ball Return Guides (2) |
| 45. | Ball Return Guide Cap Seal |
| 46. | Ball Return Guide Cap |
| 46A. | Ball Return Guide Clip |
| 47. | Allen or Torx Head Screws (2) |
| *47A. | Lock Tabs (2) |
| 47B. | Hex Head Bolts (2) |
| 48. | Sector Shaft |
| 49. | Sector Shaft Adjusting Screw |
| 50. | Retainer |

| ITEM NO. | DESCRIPTION |
|---|---|
| 51. | Retaining Ring |
| 52. | Side Cover Seal (Two piece) |
| *53. | Teflon Backup Washer |
| 54. | Steel Backup Washer |
| 55. | Side Cover Gasket |
| 56. | Side Cover Ass'y |
| 57. | Vent Plug |
| 58. | Jam Nut |
| 59. | Special Ring Head Bolts (8) |
| 60. | Seal Protector Boot |
| 61. | Grease Fitting |
| 62. | Seal Protector |

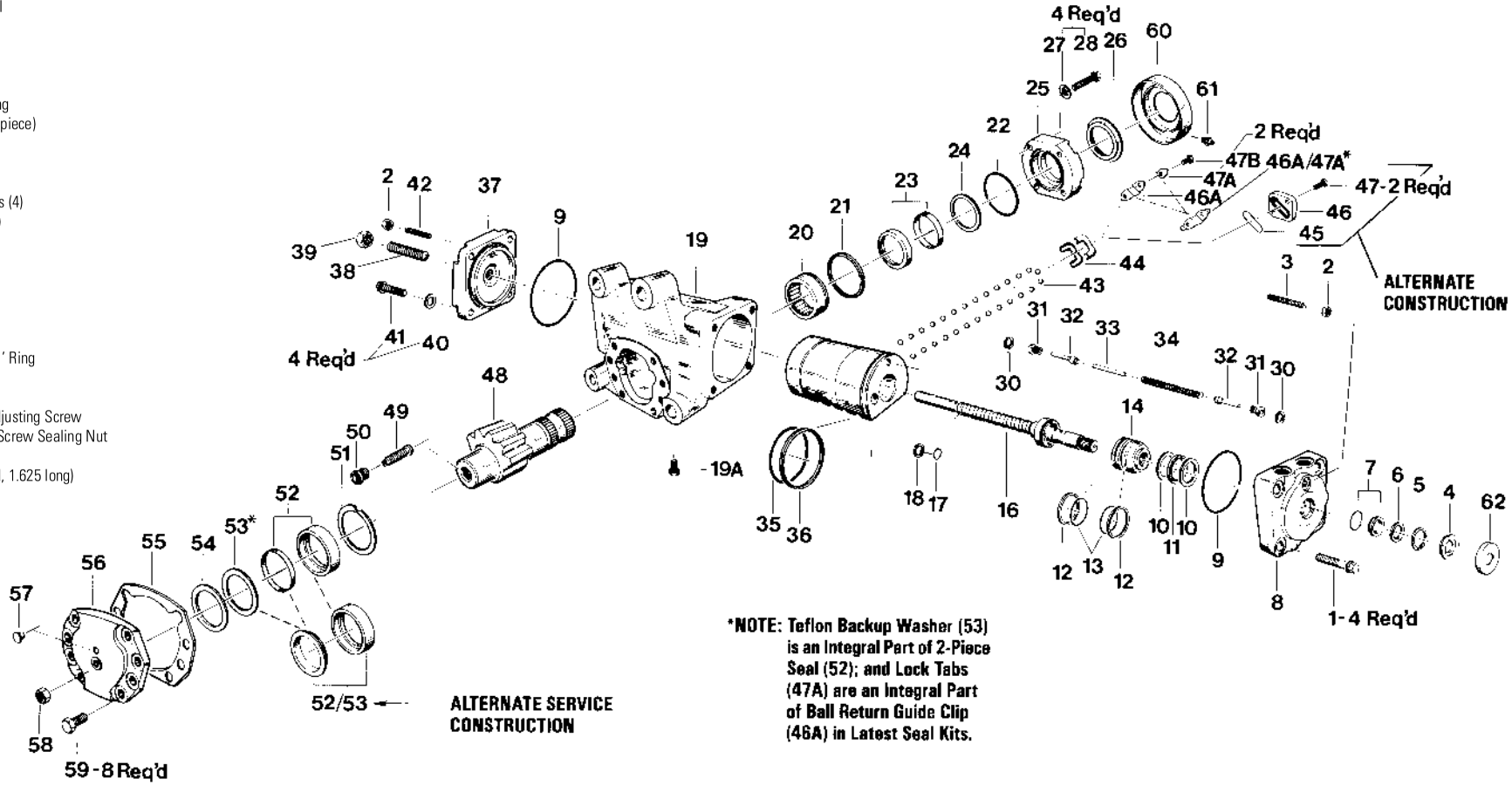

4 Req'd
2 Req'd
47-2 Req'd
ALTERNATE CONSTRUCTION
4 Req'd
-19A
52/53
ALTERNATE SERVICE CONSTRUCTION
59-8 Req'd
1-4 Req'd
*NOTE: Teflon Backup Washer (53) is an Integral Part of 2-Piece Seal (52); and Lock Tabs (47A) are an Integral Part of Ball Return Guide Clip (46A) in Latest Seal Kits.

# HFB70 Exploded Assembly View - Typical

| ITEM NO. | DESCRIPTION |
|---|---|
| 1. | Valve Housing Bolts (4 used, 2.125 long) |
| 2. | Poppet Screw Sealing Nuts (2) |
| 3. | Poppet Adjusting Screw |
| 4. | Dirt and Water Seal |
| 5. | Retaining Ring |
| 6. | Steel Backup Washer |
| 7. | Input Shaft Seal (Two piece) |
| 8. | Valve Housing |
| 9. | End Cover and Valve Housing Seal Rings |
| 10. | Trust Washer (2) |
| 11. | Thrust Bearing |
| 12. | Teflon Seal Rings (2) |
| 13. | Backup "O" Rings (2) |
| 14. | Valve Sleeve |
| 16. | Worm Shaft/Input Shaft |
| 17. | Worm Shaft Backup "O" Ring |
| 18. | Teflon Worm Shaft Seal |
| 19. | Housing |
| 19A. | Bleed Screw |
| 20. | Housing Bearing |
| 21. | Retaining Ring |
| 22. | Trunnion Cover Seal Ring |
| 23. | Sector Shaft Seal (Two piece) |
| 24. | Backup Washer |
| 25. | Trunnion Cover |
| 26. | Dirt and Water Seal |
| 27. | Trunnion Cover Washers (4) |
| 28. | Trunnion Cover Bolts (4) |
| 29. | Rack Piston |
| 30. | Retaining Rings (2) |
| 31. | Poppet Seats (2) |
| 32. | Poppets (2) |
| 33. | Spacer Rod |
| 34. | Spring |
| 35. | Rack Piston Backup "O"' Ring |
| 36. | Teflon Rack Piston Seal |
| 37. | End Cover |
| 38. | Worm Shaft Preload Adjusting Screw |
| 39. | Worm Shaft Adjusting Screw Sealing Nut |
| 40. | End Cover Washers (4) |
| 41. | End Cover Bolts (4 used, 1.625 long) |

| ITEM NO. | DESCRIPTION |
|---|---|
| 42. | Poppet Adjusting Screw |
| 43. | Balls (34) |
| 44. | Ball Return Guides (2) |
| 45. | Ball Return Guide Cap Seal |
| 46. | Ball Return Guide Cap |
| 46A. | Ball Return Guide Clip |
| 47. | Allen or Torx Head Screws (2) |
| *47A. | Lock Tabs (2) |
| 47B. | Hex Head Bolts (2) |
| 48. | Sector Shaft |
| 49. | Sector Shaft Adjusting Screw |
| 50. | Retainer |

| ITEM NO. | DESCRIPTION |
|---|---|
| 51. | Retaining Ring |
| 52. | Side Cover Seal (Two piece) |
| *53. | Teflon Backup Washer |
| 54. | Steel Backup Washer |
| 55. | Side Cover Gasket |
| 56. | Side Cover Ass'y |
| 57. | Vent Plug |
| 58. | Jam Nut |
| 59. | Special Ring Head Bolts (8) |
| 60. | Seal Protector Boot |
| 61. | Grease Fitting |
| 62. | Seal Protector |


4 Req'd
2 Req'd
47-2 Req'd
ALTERNATE CONSTRUCTION
4 Req'd
-19A
52/53
ALTERNATE SERVICE CONSTRUCTION
1-4 Req'd
59-8 Req'd
*NOTE: Teflon Backup Washer (53) is an Integral Part of 2-Piece Seal (52); and Lock Tabs (47A) are an Integral Part of Ball Return Guide Clip (46A) in Latest Seal Kits.

# Torque Chart

| Part Name | Item Number | Torque |
|---|---|---|
| Trunnion Cover Bolts | 28 | 15-22 ft. lbs. (20-30 N m) |
| Trunnion Cover Bolts | 28 If Lubricated | 11-16 ft. lbs. (15-22 N m) |
| Worm Shaft Preload Adjusting Screw | 38 | 60-70 in. lbs. (6.8-7.9 N m) |
| Worm Shaft Adjusting Screw Sealing Nut | 39 | 70-80 ft. lbs. (95-108 N m) |
| Poppet Adjusting Screw Sealing Nuts | 2 | 12-18 ft. lbs. (16-24 N m) |
| Poppet Seats | 31 | 20-25 ft. lbs. (27-34 N m) |
| Hex Head Bolts | 47B | 14-22 ft. lbs. (19-30 N m) |
| Allen or Torx Head Screws | 47 | 14-22 ft. lbs. (19-30 N m) |
| End Cover Bolts | 41 | 150-170 ft. lbs. (203-230 N m) |
| End Cover Bolts | 41 If Lubricated | 108-128 ft. lbs. (146-174 N m) |
| Valve Housing Bolts | 1 | 150-170 ft. lbs. (203-230 N m) |
| Valve Housing Bolts | 1 If lubricated | 108-128 ft. lbs. (146-174 N m) |
| Special Bolts | 59 | 150-170 ft. lbs. (203-230 N m) |
| Special Bolts | 59 If lubricated | 108-128 ft. lbs. (146-174 N m) |
| Bleed Screw | 19A | 27-33 in. lbs. (3.1-3.7 N m) |
| Pitman Arm Clamp Bolt | Lubricated/Plated | 300-320 ft. lbs. (407-434 N m) |
| Pitman Arm Clamp Bolt | Dry/Unplated | 380-420 ft. lbs. (515-569 N m) |
| Jam Nut | 58 | 40-45 ft. lbs. (54-61 N m) |

Universal joint bolts-torque to vehicle manufacturer's specifications.

All torques specified in this manual are for dry/unplated parts unless otherwise specified.

# Tools and Materials Required for Servicing

Manual
Tape
Grease, Wheel bearing grease
Grease—**Mobil Temp 1 or 2 or equivalent
Special Tools:*
- Seal Installation Tool J26739
- Seal Compression Tool J26740
- Seal installation Tool J26741
- Seal Compression Tool J26742
- Seal Driving Tool J28490
- Bearing Mandrel J26743

Adjustable wrench
Knife Chisel
Torque Wrench-in. lbs. IN m)
Torque Wrench-ft. lbs. IN m)
Soft Punch
Retaining Ring pliers
Ratchet
Sockets: 112, 13/16, 15/16 inch
Allen sockets: 5/16, 5/32 inch
12-point sockets: 11/16, 314, 13/ 16 inch
Torx sockets: T-30
Pitman arm puller
Screw driver
Slot type screwdriver socket

***NOTE: SPECIAL TOOLS ARE AVAILABLE FROM:**

Kent-Moore Tool Division
29784 Little Mack
Roseville, MI 48066
Phone: 313-574-2332 or 1-800-328-6657

For complete HFB70 service tool set, order Part No. J26837.

**Mobile Temp is a Registered Trademark of Mobile Oil Co.

# Disassembly

## Preparation

- THOROUGHLY CLEAN OFF ALL OUTSIDE DIRT, ESPECIALLY FROM AROUND FITTINGS AND HOSE CONNECTIONS, BEFORE YOU REMOVE THE GEAR.
- Drain the steering gear assembly.
- Remove input and output shaft connections per 1.1 and 2.1, Page 11 and 14.
- Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

**WARNING: THIS STEERING GEAR WEIGHS APPROXIMATELY 112 POUNDS, 51 KG, DRY. EXERCISE CAUTION WHEN YOU REMOVE, LIFT, OR CARRY IT. DO NOT POUND THE UNIVERSAL JOINT OR INPUT SHAFT COUPLING ON OR OFF THE INPUT SHAFT. INTERNAL DAMAGE TO THE STEERING GEAR CAN RESULT.**

- Remove the steering gear from the vehicle and take it to a clean surface (a piece of wrapping paper makes an excellent disposable top)
- Clean and dry the gear before you start to disassemble it.
- As you disassemble the gear, clean all parts in clean, petroleum-based solvent, and blow them dry only.

**WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH. WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.**

**CAUTION: Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts.**

- Keep each part separate to avoid nicks and burrs.
- Discard all seals, O-rings, and gaskets removed from the gear. Replace them with new parts only.

## Disassembly

**position gear & sector shaft**

1. Position the steering gear firmly in a vise with the gear's worm shaft/input shaft (16) in a horizontal direction. Prepare for fluid drainage and unplug fluid line ports. Rotate worm shaft/input shaft with an 11/16 inch or 3/4 inch 12 point socket or box end wrench, through the gear travel several times to purge hydraulic fluid from the unit. Then position the timing mark located on the end of the sector shaft (48) to a vertical direction. SEE FIGURE 40.

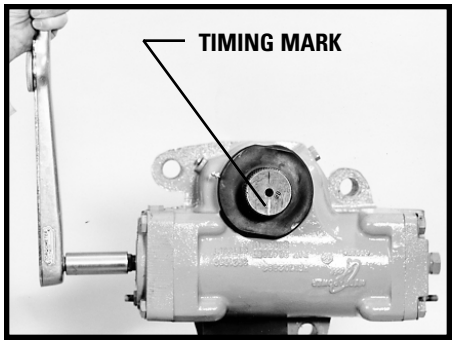


Figure 40

**CAUTION**

**CAUTION: Clamp only against housing mounting bosses or attach a plate to the mounting bosses for this purpose. Do not clamp against the body of housing.**

**remove protector boot & dirt and water seal**

2. Remove protector boot (60), grease fitting (61) and the dirt and water seal (26) from the trunnion cover (25). SEE FIGURE 41. Discard boot and seal.

Figure 41

**clean sector shaft and loosen jam nut**

3. Remove any paint or corrosion from the exposed area of the sector shaft (48), and loosen the jam nut (58) on the sector shaft adjusting screw (49). 3/4 inch socket required.

**remove trunnion cover bolts & washers**

4. Remove the four bolts (28) and washers (27) from the trunnion cover with a 1/2 inch socket. SEE FIGURE 42.

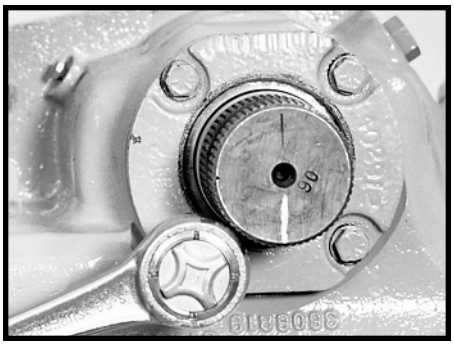


Figure 42

**remove trunnion cover and seal package**

5. Remove the trunnion cover (25). Remove and discard the seal ring (22), the two piece sector shaft seal (23) and the Teflon back-up washer (24) from the trunnion cover. SEE FIGURE 43.

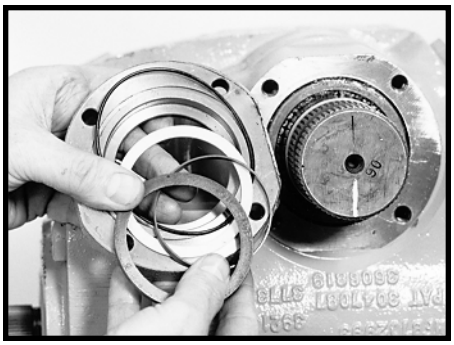


Figure 43

**tape sector shaft**

6. Tape the serrations and bolt groove of the sector shaft (48) with one layer of masking tape to prevent loose bearing rolls from "hanging up" the sector shaft during its removal. The tape should not extend on to the sector shaft bearing diameter. SEE FIGURE 44.

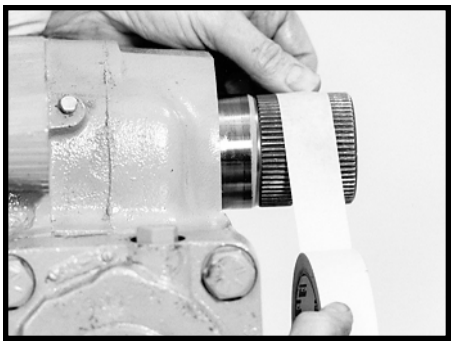


Figure 44

**remove side cover bolts**

7. Prepare for fluid to drain, and remove eight special ring head bolts (59) from the side cover (56) with a 13/16 inch socket. SEE FIGURE 45.

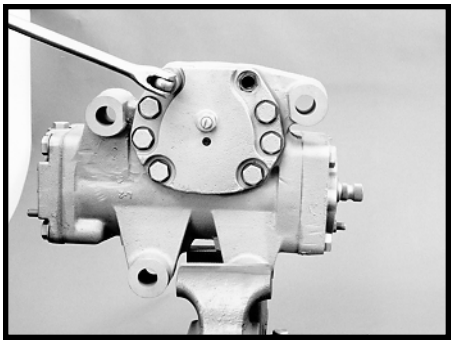


Figure 45

**NOTE**

**NOTE: These bolts are special because they are equipped with either a ring or washer design on the underside of the head. If you replace one or more bolts, you must use bolts of either design and of the SAME SPECIAL TYPE AND LENGTH AS THOSE YOU REMOVED. Do not use a substitute. You can get these bolts through your OEM parts distributor. SEE FIGURE 46.**

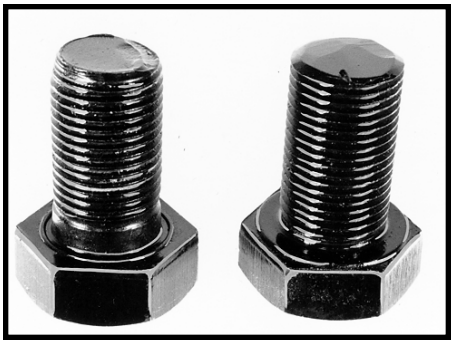


Figure 46

**begin to remove side cover & sector shaft**

8. Begin to remove the side cover (56) and sector shaft (48) as an assembly. SEE FIGURE 47. Stop removal when the bearing rolls in the housing bearing (20) are half exposed. Coat the bearing rolls with grease. As a means of starting the removal of the side cover and sector shaft assembly, you may use a soft hammer or wooden hammer handle. SEE FIGURE 48.

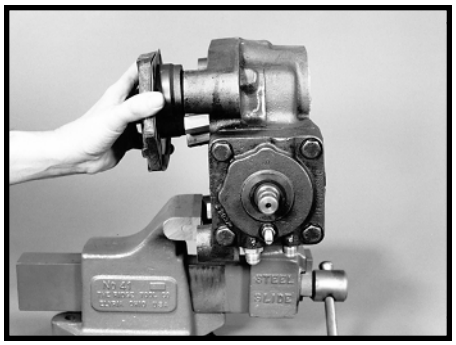


Figure 47

**NOTE**

**NOTE: When the bearing rolls are half exposed and it is evident that the unit has a caged bearing (rolls retained), the following caution note does not apply.**

**CAUTION**

**CAUTION: Take care to remove this assembly slowly, or it may come out too quickly for you to retain the loose bearing rolls in the housing bearing race. Follow the shaft end with the bearing tool (J26743) to retain the rolls, or when the rolls are half exposed, be sure to coat them with grease to retain them in the housing bearing. If one or more of the rolls is lost, you must replace the entire bearing.**

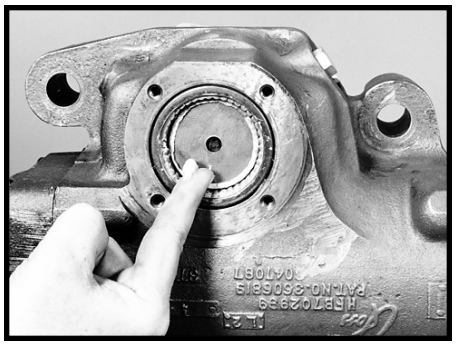


Figure 48

**remove side cover and sector shaft**

9. Finish removing the side cover (56) and sector shaft (48) as an assembly. Remove side cover gasket (55) and discard.

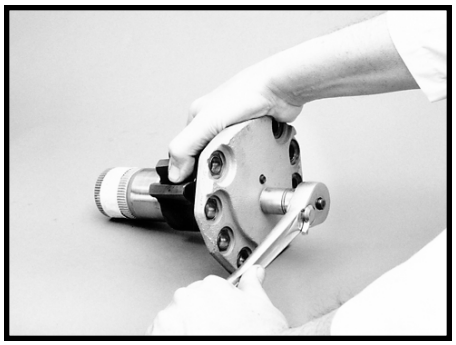


Figure 49

**CAUTION**

**CAUTION: The bearing may contain 41 or 42 rolls, depending upon the type used. Bearing BR-970 has 41 rolls. Bearing BR 9701 has 42 rolls. The identification number can be found on the outside edge of the bearing race flange. There is also a set of bearing rolls in the side cover, with either 41 or 42 rolls. The quantity may not be the same as in the housing bearing. Do not mix these rolls.**

**remove bearing rolls**

10. If the housing (19) bearing has loose rolls, the bearing rolls from the bearing (20) race, count them and put them aside as a set for cleaning, inspecting and reassembly.

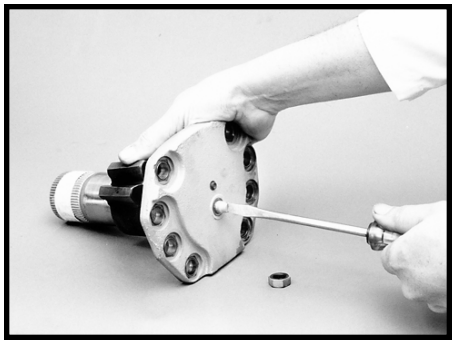


Figure 50

**remove jam nut**

11. Remove the sector shaft adjusting screw jam nut (58). SEE FIGURE 49. 3/4 inch socket required.

**remove sector shaft**

12. Screw the sector shaft adjusting screw (49) through the side cover (56) SEE FIGURE 50. Place the side cover exterior face down and lift the sector shaft (48) out vertically. SEE FIGURE 51.

Figure 51

**NOTE**

**NOTE: If the side cover bearing assembly has uncaged (loose) rolls, the vertical position will allow the side cover bearing rolls to fall into the side cover, where you may easily collect and count them. Immediately gather all of the side cover bearing rolls and count them.**

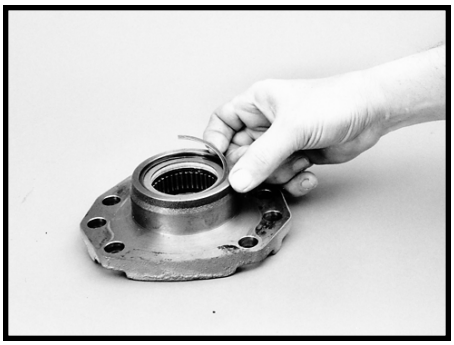


Figure 52

**CAUTION**

**CAUTION: Take care not to lose any rolls during disassembly and assembly, or you will have to replace the complete side cover assembly.**

**WARNING**

**WARNING: IF THE BEARING IS THE UNCAGED (LOOSE) ROLL TYPE, DO NOT MIX THE ROLLS FROM THE SIDE COVER WITH THE ROLLS FROM THE HOUSING BEARING. THE BEARING RACE AND ROLLS ARE A MATCHED SET. INTERCHANGING THE ROLLS COULD RESULT IN PREMATURE BEARING OR SEAL FAILURE, WHICH COULD CAUSE A LOSS OF POWER STEERING.**

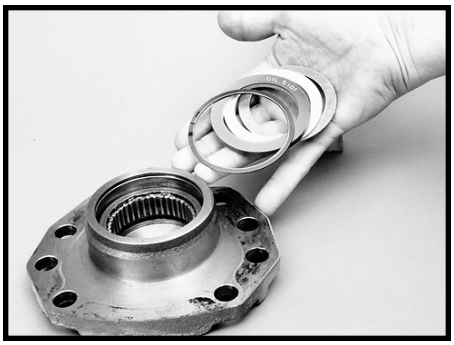


Figure 53

**remove side cover seal pack**

13. Remove the retaining ring (51), the two-piece side cover seal (52), the Teflon backup washer (53). and the steel backup washer (54) from the side cover. Discard seal and Teflon washer. SEE FIGURES 52, 53. Remove and discard vent plug (57).

Figure 54

**remove retainer and adjusting screw**

14. Only if replacement of the retainer (50) and or adjusting screw (49) is required (see inspection procedure 8 page 33), place the sector shaft (48) firmly in a soft jawed vise and unstake the retainer using a suitable chisel. Turn the retainer out of the sector shaft pocket and remove the adjusting screw. Discard the retainer. SEE FIGURE 54.

**loosen worm shaft & poppet nuts & screws**

15. Loosen the worm shaft adjusting screw sealing nut (39) with a 1-1/16 inch box end wrench, and loosen the worm shaft preload adjusting screw (38) approximately two turns with a 5/16 inch allen socket or screw driver. SEE FIGURE 55. Loosen the poppet adjusting screw sealing nut (2) and the poppet adjusting screw (42) approximately two turns. An 11/16 inch box end required.

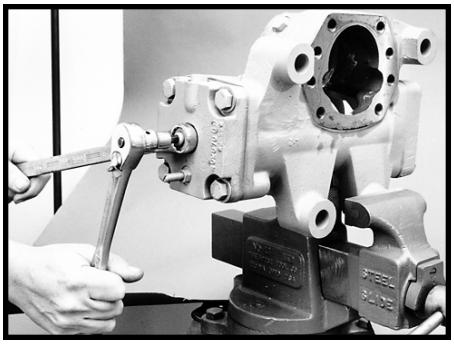


Figure 55

**remove end cover bolts**

16. Remove the four end cover bolts (41) with a 13/16 inch socket and remove four washers (40). SEE FIGURE 56.

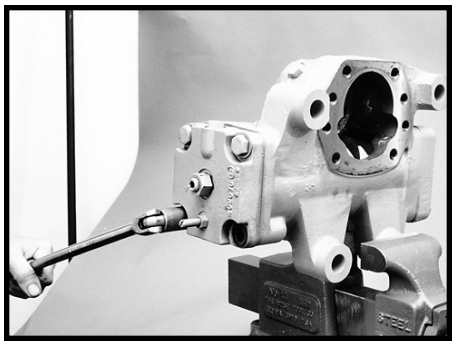


Figure 56

**remove end cover**

17. Remove the end cover (37). Some fluid will drain. SEE FIGURE 57.

**NOTE**

**NOTE: The worm shaft adjusting screw and sealing nut and poppet adjusting screw and sealing nut do not have to be removed from the end cover (37) unless apparent fluid leaks at the adjusting screws indicate the sealing nuts and or screws be replaced.**

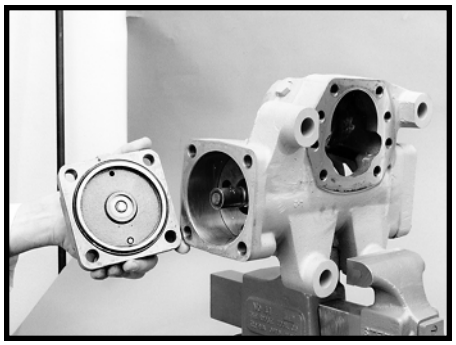


Figure 57

**remove seal ring**

18. Remove and discard the end cover seal ring (9) from the end cover (37). SEE FIGURE 58.

**remove seal protector**

19. Remove seal protector (62) from worm shaft/input shaft (16) and discard.

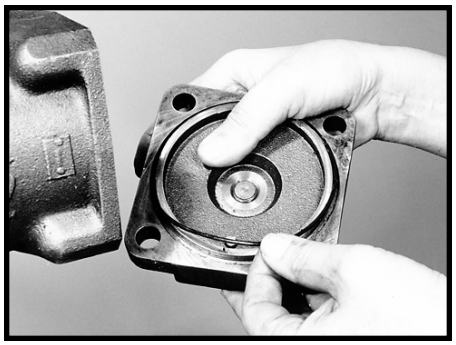


Figure 58

**clean input shaft**

20. Clean any paint or foreign material from the input shaft with a fine grade emery paper. SEE FIGURE 59.

**loosen poppet nut & screw**

21. Loosen the poppet adjusting screw sealing nut (2) and the poppet adjusting screw (3) in the valve housing (8) approximately two turns.

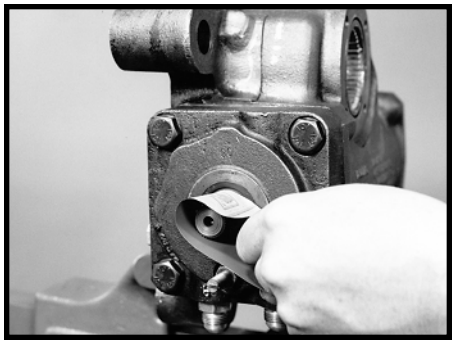


Figure 59

**remove valve housing bolts**

22. Remove the four valve housing bolts (1) with a 13/16 inch socket. SEE FIGURE 60.

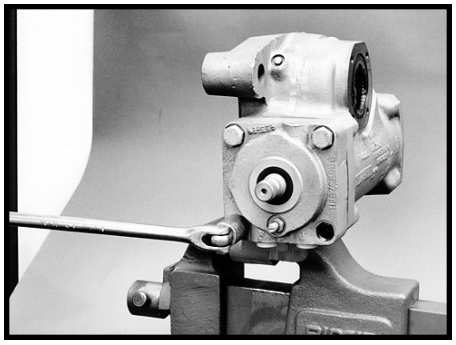


Figure 60

**remove valve housing**

23. Remove the valve housing (8). Some fluid will drain. SEE FIGURE 61.

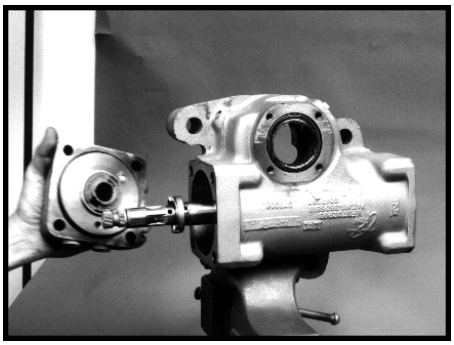


Figure 61

**NOTE**

**NOTE: The valve sleeve (14) will probably remain in the valve housing.**

**WARNING**

**WARNING: DO NOT DISASSEMBLE THE WORM SHAFT/INPUT SHAFT ASSEMBLY (16), WHICH INCLUDES THE WORM SHAFT, INPUT SHAFT, TORSION BAR, TORSION BAR PINS, DRIVE RING AND DRIVE RING RETAINER, AND INSERT. DO NOT UNBEND THE DRIVE RING RETAINER TANGS THAT HOLD THE DRIVE RING IN PLACE. SEE FIGURE 62. DOING EITHER WILL ALTER THE VALVE TIMING, WHICH COULD CAUSE THE VEHICLE TO PULL TO ONE SIDE OR THE OTHER.**

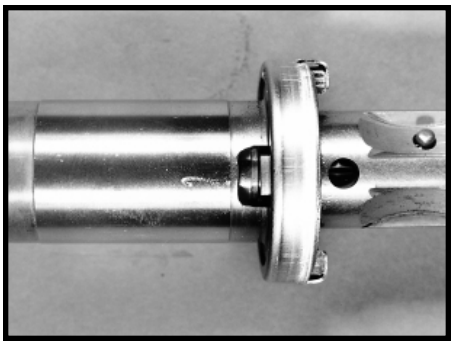


Figure 62

**remove valve sleeve**

24. Remove the valve sleeve (14) from the valve housing (8). SEE FIGURE 63.

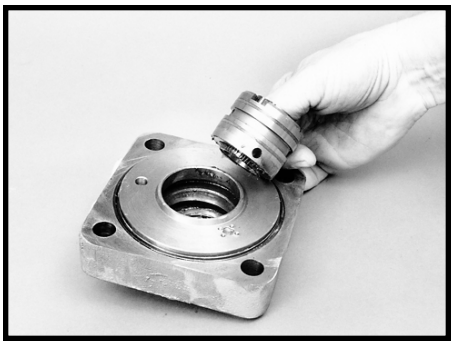


Figure 63

**remove thrust washers & bearing**

25. Remove the first thrust washer (10) and the thrust bearing (11) and then the second thrust washer (10) from the valve housing. SEE FIGURE 64.

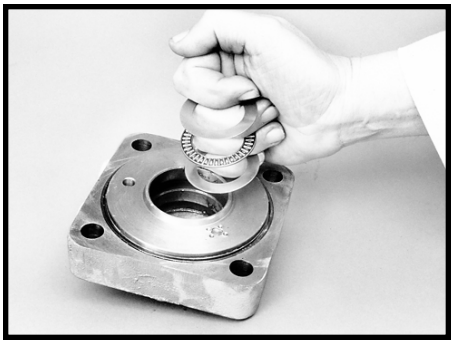


Figure 64

**NOTE**

**NOTE: The first thrust washer may stay on the end of the valve sleeve.**

**remove seal rings**

26. Remove and discard the valve housing seal ring (9) from the valve housing (8)

**remove dirt & water seal**

27. Remove and discard the dirt and water seal (4). SEE FIGURE 65.

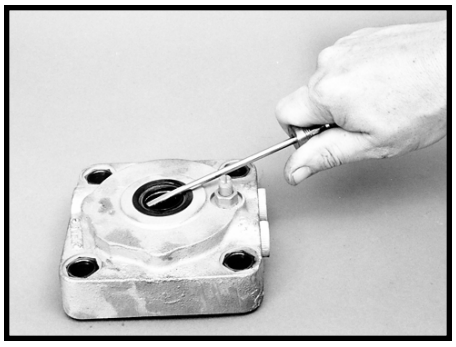


Figure 65

**remove retaining ring**

28. Remove retaining ring (5). SEE FIGURE 66.

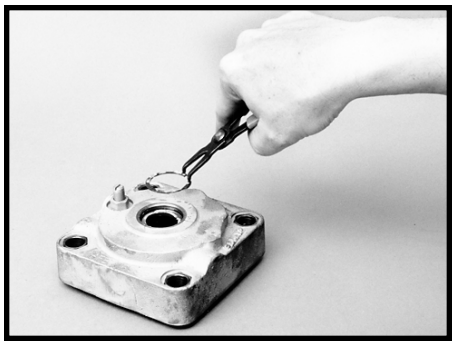


Figure 66

**remove valve housing seal pack**

29. Remove steel backup washer (6), and two-piece input shaft seal (7) from the valve housing (8). SEE FIGURE 67. Discard seal.

**NOTE**

**NOTE: The poppet adjusting screw (3) and sealing nut (2) do not have to be removed from valve housing unless apparent leaks at the adjusting screw indicate sealing nut and or adjusting screw be replaced.**

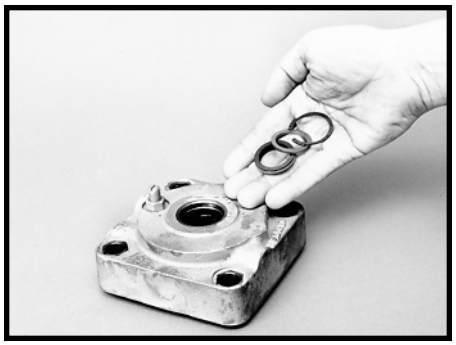


Figure 67

**remove seal rings**

30. Remove and discard the two Teflon seal rings (12) from valve sleeve (14). SEE FIGURE 68.

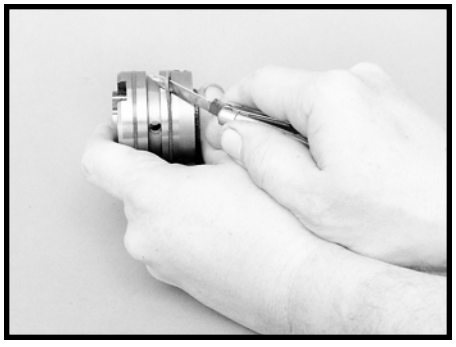


Figure 68

**remove "O" rings**

31. Remove the two backup "O" rings (13) from the valve sleeve grooves. SEE FIGURE 69.

Figure 69

**remove rack piston & worm shaft**

32. Remove the rack piston (29) worm shaft/ input shaft (16) assembly from the gear housing (19). SEE FIGURE 70. Lay the rack piston (29) worm shaft (6) assembly on a clean rag to keep the piston from rolling.

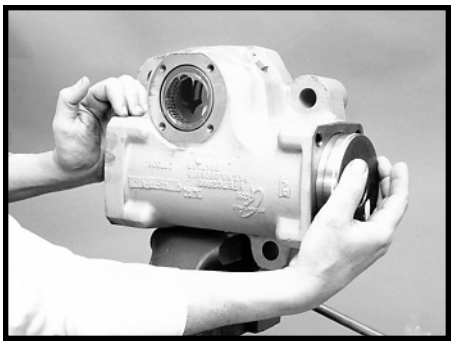


Figure 70

**NOTE**

**NOTE: The worm shaft part of the assembly will be inside the rack piston, with the input shaft part of the worm protruding from the rack piston. Take care when removing this assembly from the housing. To prevent the teflon rack piston seal (36) from getting caught in the sector shaft cavity, remove the worm shaft rack piston assembly from the long end of the housing.**

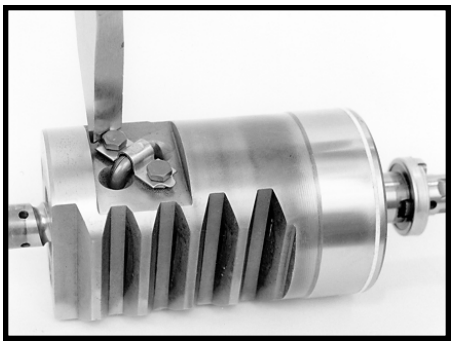


Figure 71

**remove ball return guide clip, if equipped**

33. For rack pistons with the ball return guide clip (46A), bend the tangs down that are on the clip or on the two locking tabs (47A). SEE FIGURE 68. Remove the two hex head bolts (47B), lock tabs and clip. Discard lock tabs. SEE FIGURE 72. 1/2 inch hex socket required.

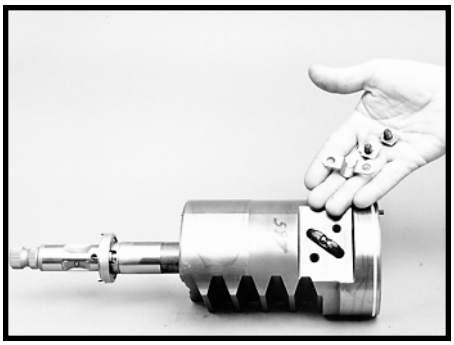


Figure 72

**NOTE**

**NOTE: The current HFB70 units and seal kits will utilize a ball return guide clip (46A/47A) with the two tabs integral to it.**

**NOTE**

**NOTE: If the seal kit being used includes a ball return guide clip (46A/47A) with integral lock tabs, discard the ball return guide clip removed from the unit.**

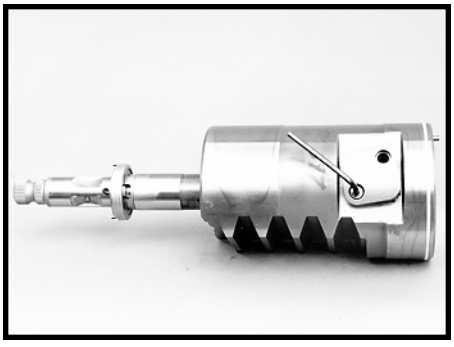


Figure 73

**remove ball return guide cap, if equipped**

34. For a rack piston with the ball return guide cap (46) instead of the clip, remove the two special screws (47) which will require either a 5/32 inch allen wrench or a T-30 Torx wrench. SEE FIGURE 73. Remove the ball return guide cap and the ball return cap seal (45). SEE FIGURE 74. Discard screws and cap seal.

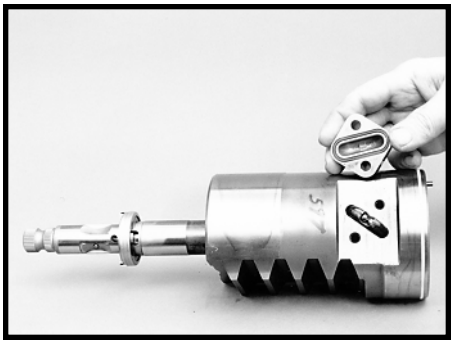


Figure 74

**remove guides & balls**

35. Remove the two ball return guide halves (44). SEE FIGURE 75. Remove the balls (43) from the rack piston (29) by rotating the worm shaft/input shaft (16) until the 34 balls fall out. SEE FIGURE 76.

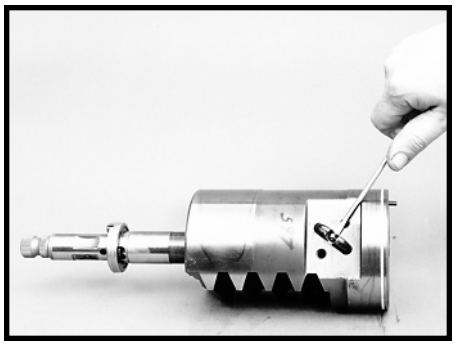


Figure 75

**CAUTION**

**CAUTION: Assembly contains a set of 34 matched balls, and you must take special care not to lose any. If any balls are lost, a complete, new set of matched balls will be required.**

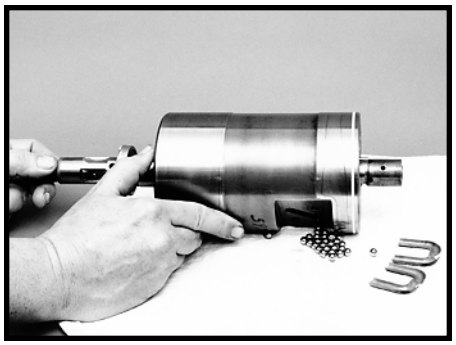


Figure 76

**WARNING**

**WARNING: INCORRECT MATCHING OF BALLS, WORMSCREW AND RACK PISTON CAN RESULT IN LOSS OF STEERING, WHICH COULD RESULT IN AN ACCIDENT.**

**NOTE**

**NOTE: Ball return guides are closely fitted with the rack piston and you may have to remove them by carefully inserting a screw driver between the rack piston and the ball return guides. See composite picture of both types of rack piston assemblies and two types of ball guides. SEE FIGURE 77.**

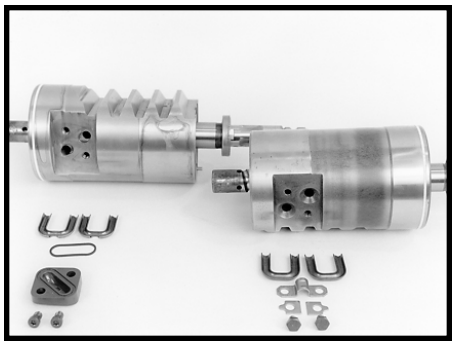


Figure 77

**remove worm shaft**

36. Remove the worm shaft/input shaft (16) from the rack piston (29). SEE FIGURE 78.

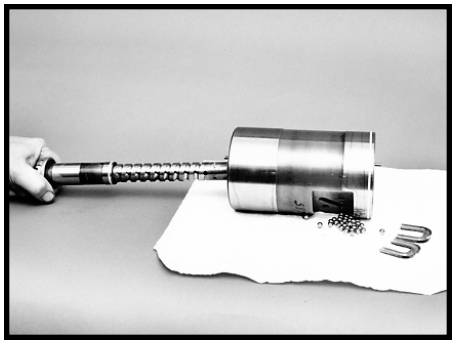


Figure 78

**remove seal ring**

37. Remove and discard the rack piston seal ring (36). SEE FIGURE 79.

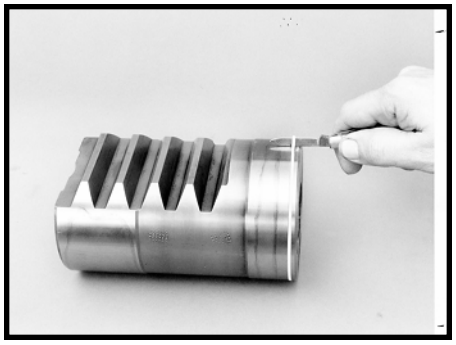


Figure 79

**remove rack piston "O" ring**

38. Remove and discard the rack piston backup "O" ring (35) from the rack piston. SEE FIGURE 80.

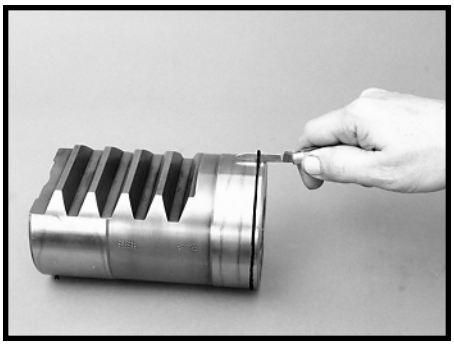


Figure 80

**remove worm shaft seal and "O" ring**

39. Remove and discard the worm shaft seal ring (18). Then, remove and discard the worm shaft "O" ring (17) from the worm shaft/input shaft (16). SEE FIGURE 81.

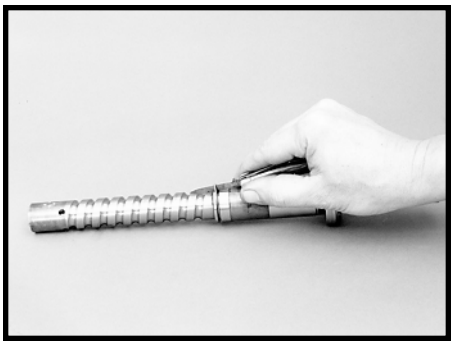


Figure 81

**CAUTION**

**CAUTION: This completes the extent that the worm shaft/input shaft (16) may be disassembled for service. See Warning on Page 25.**

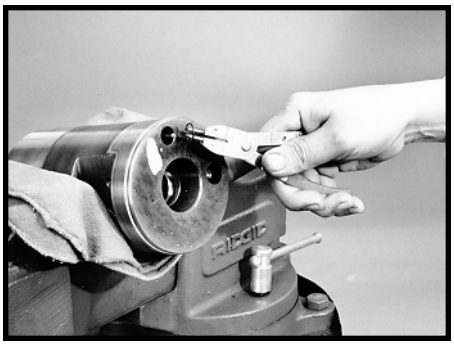


Figure 82

**WARNING**

**WARNING: DURING STEP 40 YOU SHOULD WEAR EYE PROTECTION, AS THE SPRING LOADED POPPETS COULD EJECT, AND CAUSE EYE INJURY.**

**remove poppets, if necessary**

40. It is not usually required to service the poppet assembly. If required, however, position the rack piston (29) carefully in a vise equipped with soft jaws. Then, remove two retaining rings (30), two poppet seats (31), two poppets (32), nylon spacer rod (33), and spring (34). SEE FIGURES 82, 83, 84

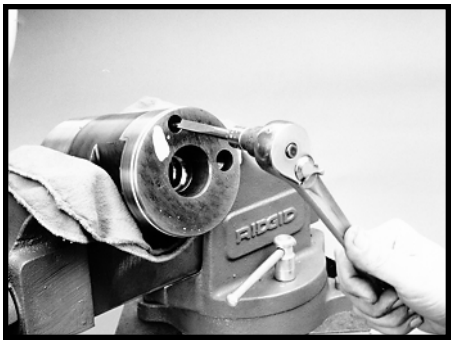


Figure 83

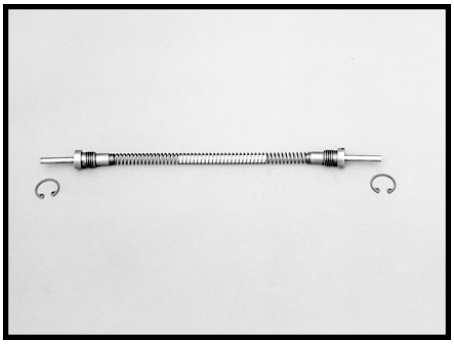


Figure 84

**remove housing bearing if necessary**

41. The housing bearing assembly (20) or race should only be removed if you determine that the bearing must be replaced after following inspection procedures 4, 5 and 6 on page 32. Remove the bearing in the following manner: Use bearing mandrel (special tool) J26743 to apply pressure from the side cover opening and press the bearing out through the trunnion cover opening. SEE FIGURE 85. Maintain a good, square contact between the housing and press base to avoid damaging the housing bearing bore. Remove retaining ring (21) from bearing. Discard bearing.

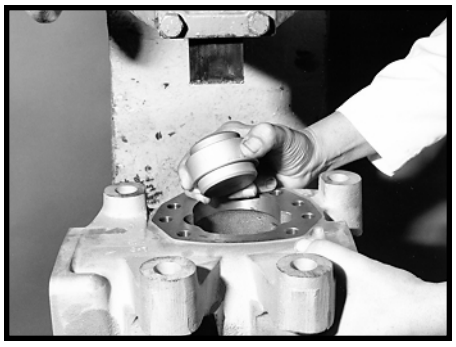


Figure 85

**CAUTION**

**CAUTION: If the bearing is cocked while you press it out, it will burnish the bore, causing it to become oversized. You will then have to replace the gear housing.**

**NOTE**

**NOTE: Service housing assembly includes: housing (19), bearing assembly (20), retaining ring (21) and bleed screw (19A).**

**remove bleed screw**

42. Remove bleed screw (19A). A 5/16 inch socket required. SEE FIGURE 86.

This completes the disassembly of the HFB70 steering gear.

Figure 86

# Inspection

- Check to make sure that all sealing surfaces and seal cavities are free from nicks and corrosion. If any part is nicked or corroded where sealing occurs, you must replace the part to insure proper sealing.

- Wash all parts in clean petroleum-based solvent. Blow them dry only.

**WARNING**

**WARNING: SINCE THEY ARE FLAMMABLE, BE EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.**

**WARNING**

**WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS.**

**inspect rack piston teeth**

1. Inspect the rack piston (29) teeth for cracks and wear. If you can detect a step by running your fingernail horizontally across the teeth surface, you must replace both the rack piston and sector shaft (48) and use a set of 34 service balls (43). SEE FIGURE 87.

**inspect rack piston internal grooves**

2. Inspect the rack piston internal ball-track grooves for brinelling (dents) or spalling (flaking). SEE FIGURE 88. If either condition exists, you must replace all of the following parts: the rack piston (29), the worm shaft/input shaft assembly (16), the valve sleeve (14) and the set of 34 balls (43).

**inspect worm shaft**

3. Inspect the worm shaft/input shaft assembly (16) ball track grooves for brinelling or spalling. SEE FIGURE 89. If either condition exists, you must replace all of the following parts: the worm shaft/input shaft assembly (16), the rack piston (29), the valve sleeve (14), the set of 34 balls. Visually inspect the upper shaft seal area near the input shaft serrations for nicks, and run your fingernail edge across the sealing surface to detect steps. SEE FIGURE 90. Visually inspect the sleeve (14) contact area of the worm shaft/ input shaft for discoloration from excess heat. If either of these conditions exist you must replace the worm shaft/input shaft assembly (16) and valve sleeve (14) as a matched set.

**NOTE**

**NOTE: The input shaft is pinned to the worm shaft by the torsion bar pin, and the assembly is flexible and may appear slightly bent at this joint. This slight bend is normal. SEE FIGURE 91.**

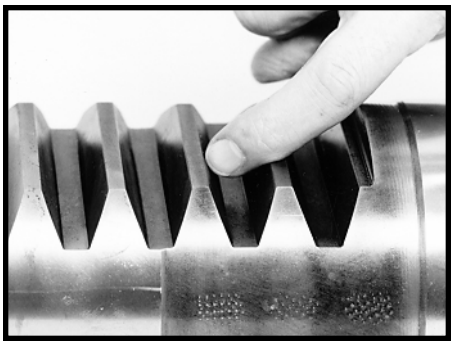


Figure 87

Figure 88

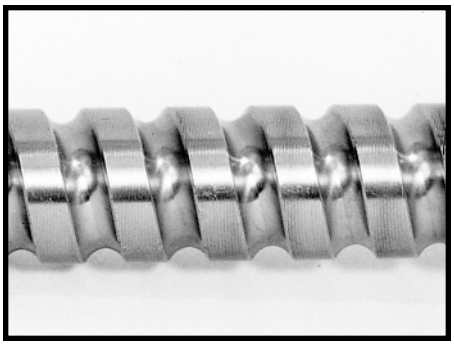


Figure 89

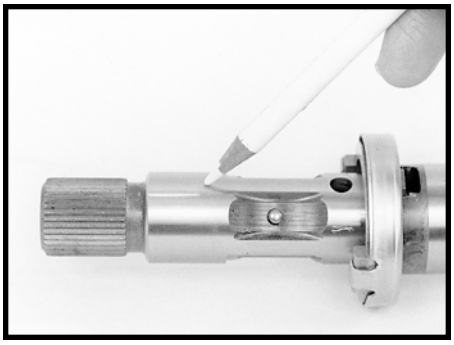


Figure 90

Figure 91

**inspect housing cylinder bore**

4. Inspect the housing (19) cylinder bore. SEE FIGURE 92. You will probably notice normal scoring marks running lengthwise through the bore. Since this scoring is normal, you should not compare it to the scoring considered detrimental in the cylinder bores of an internal combustion engine. Replace the housing only if you've tested it for internal leakage (as described in the troubleshooting section on page 7) and you've determined that the scoring, and not damaged seals, is responsible for the excessive internal leakage, greater than 1.5 gpm (5.7 liters/min.)

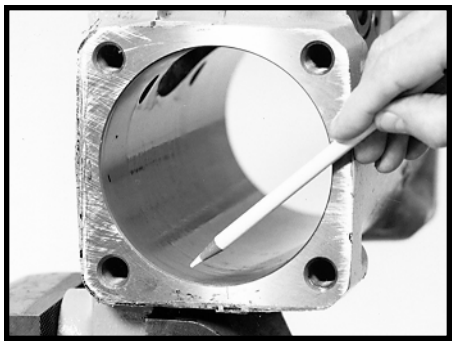


Figure 92

**NOTE**

**NOTE: In running the internal leakage test after reassembly of the unit, make sure that internal leakage exceeding 1.0 gpm (3.8 liters/min.) can only be attributed to the housing and not to the improper assembly of the new seals in the worm shaft, rack piston, and valve assembly, before you decide to replace the housing.**

**inspect housing faces**

5. Inspect the housing (19) faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-toothed flat file without changing the dimensional characteristics. SEE FIGURE 93.

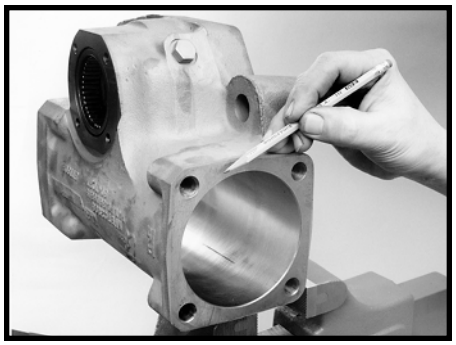


Figure 93

**inspect housing and side cover bearings**

6. Inspect the housing bearing and the side cover bearing race and rolls for brinelling or spalling. If either condition exists, replace the damaged housing bearing (20). For the housing bearing, follow disassembly step 41 and assembly step 2, Pages 30 and 34. If the side cover bearing is damaged, replace side cover assembly. SEE FIGURES 94, 95.

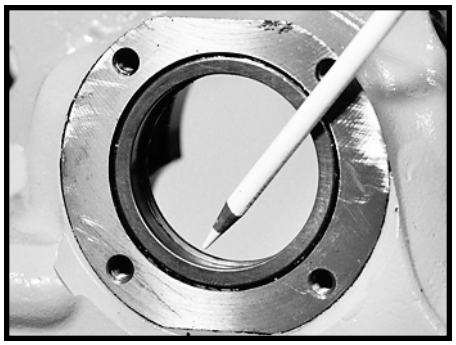


Figure 94

**WARNING**

**WARNING: FOR BEARING TYPE WITH UNCAGED (LOOSE) ROLLS DO NOT MIX THE ROLLS FROM THE SIDE COVER BEARING WITH THE ROLLS FROM THE HOUSING BEARING. THE BEARING RACE AND ROLLERS ARE A MATCHED SET, INTERCHANGING THE ROLLS COULD RESULT IN PREMATURE BEARING OR SEAL FAILURE, WHICH COULD CAUSE A LOSS OF POWER STEERING.**

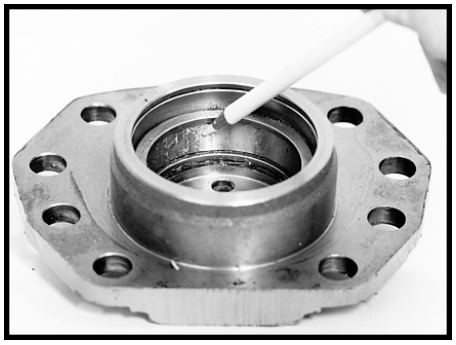


Figure 95

**inspect sector shaft assembly**

7. Inspect the sector shaft (48) bearing and sealing areas and sector teeth contact surfaces for brinelling or spalling. SEE FIGURE 96. Run your fingernail edge across these areas to detect steps. Inspect also for cracks. Remove any masking tape from the shaft serrations and inspect for twisted or otherwise damaged serrations. If any of these conditions exist, replace the sector shaft.

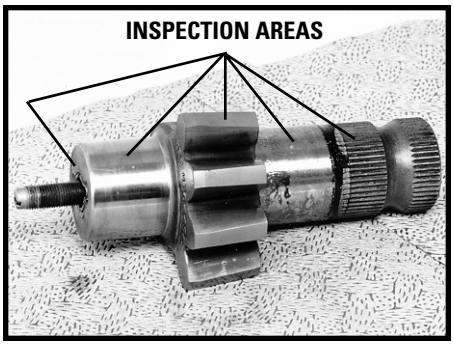


Figure 96

**NOTE**

**NOTE: A service shaft assembly will have the adjusting screw (49) and retainer (50) assembled into it. The screw (49) and retainer (50) can be serviced separately if required.**

**inspect adjusting screw and retainer**

8. Inspect the sector shaft assembly for damaged adjusting screw (49) threads. The staked retainer (50) must be locked in place, and have no cracks. The adjusting screw must rotate by hand with no perceptible end play (lash) Replace adjusting screw, if damaged. Replace the retainer, if damaged, or if the adjusting screw requires replacement or adjustment.

**inspect thrust washers and bearing**

9. Inspect the thrust bearing (11) rollers for any deterioration. Inspect the two thrust washers for brinelling, spalling, or cracks. SEE FIGURE Replace any part with these conditions.

This completes inspection of the HFB70 steering gear.

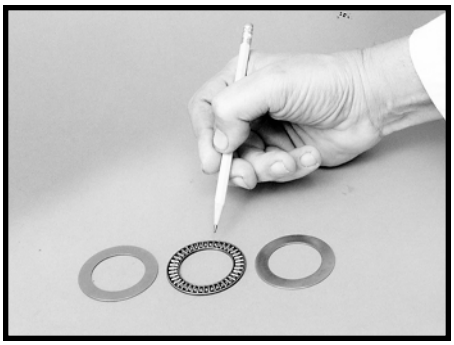


Figure 97

# Assembly

## Preparation

- Wash all parts in clean petroleum-based solvent. Blow them dry only.

**WARNING** **WARNING: SINCE THEY ARE FLAMMABLE, EXTREMELY CAREFUL WHEN USING ANY SOLVENT. EVEN A SMALL EXPLOSION OR FIRE COULD CAUSE INJURY OR DEATH.**

**WARNING** **WARNING: WEAR EYE PROTECTION AND BE SURE TO COMPLY WITH OSHA OR OTHER MAXIMUM AIR PRESSURE REQUIREMENTS**

- Replace all seals, seal rings, and gaskets with new ones each time you disassemble the gear.

- Ross Gear does provide individual seals, seal rings, and gaskets, as well as complete and partial seal kits. SEE FIGURE 98. These parts should be available thru most OEM parts distributors. (Contact your local dealer for availability 9

## Assembly

**assemble worm shaft O ring & seal ring**

1. Slide compression tool J26740, small diameter end first, onto the worm end of worm shaft/input shaft (16) until it is beyond the seal ring groove. Using seal installation tool J26739 assemble the new worm shaft o-ring (17), and then the new seal ring (18). SEE FIGURE 99, 100. Next, compress the seal ring by pulling the compression tool back over the seal ring. Allow the worm shaft/input shaft to set with compression tool in place for at least ten minutes. SEE FIGURE 101.

**CAUTION** **CAUTION: Be sure the compression tool is assembled correctly before assembly of the seal ring. If the tool is backwards it cannot be pulled over the new seal ring for compression or for tool removal without destroying the seal ring.**

**CAUTION** **CAUTION: Allow for the 10 minutes to insure that the O-ring and seal ring are properly seated when you install the worm shaft into the rack piston. If you do not allow for this time, the seal may tear or be cut when you place the worm into the rack.**

**install housing bearing and retaining ring**

2. If you are installing a new housing bearing (20) or using the old housing and bearing assembly, apply a generous amount of clean grease to the bearing race to retain the bearing rolls. Then, place the rolls into the race, being sure you have the correct quantity of rolls for your particular bearing assembly. To install the NEW bearing assembly (20) into the housing, first install the

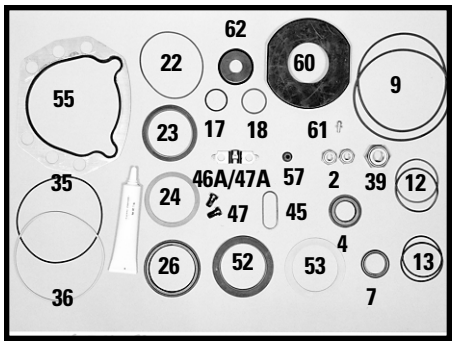


Figure 98

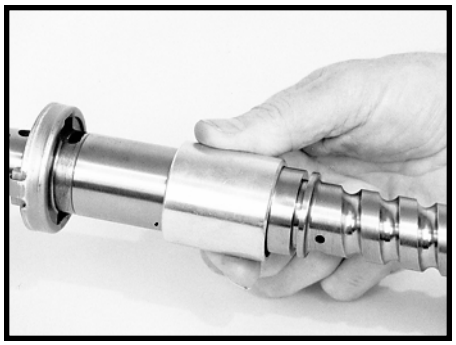


Figure 99

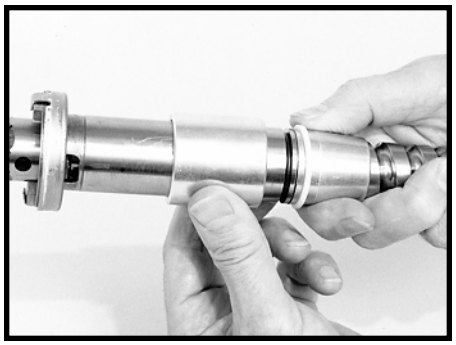


Figure 100

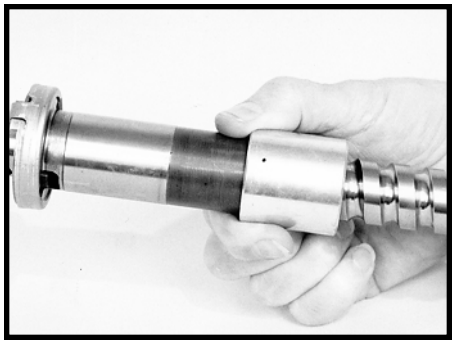


Figure 101

Figure 102

retaining ring (21) into the groove on the bearing's outside diameter. Then press the bearing into the housing from the trunnion side using bearing , mandrel (special tool) J26743 against the lettered end of the bearing shell so that the retaining ring is away from the housing bore. SEE FIGURE 102. During this procedure be sure that the housing is square with press base and the bearing is not cocked.

Figure 103

**NOTE**

**NOTE: Bearing BR 970 requires 41 rolls, and Bearing BR 970-1 requires 42 rolls.**

**CAUTION**

**CAUTION: The bearing rolls must be in place to insure proper installation of the bearing. If the rolls are improperly installed, the bearing race may col lapse and fail. The flange may break, causing premature failure of the bearing. Again, do not mix the housing bearing rolls with the side cover bearing rolls. Be sure the bearing mandrel used is clean.**

Figure 104

**NOTE**

**NOTE: The bearing assembly (20) may be of caged (retained) roll type therefore not requiring reassembly of the rolls.**

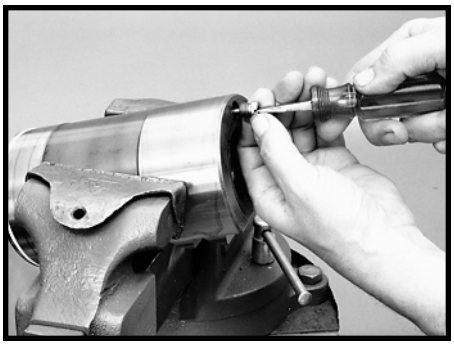


Figure 105

**install rack piston seal and O-ring**

3. Install the new rack piston backup O- ring (35) and the new Teflon rack piston seal ring (36) into the rack piston (29) ring groove. SEE FIGURES 103, 104. Do not over stretch the rings as you install them. Coat with a liberal amount of grease.

**WARNING**

**WARNING: DURING STEP 4, YOU SHOULD WEAR EYE PROTECTION, AS THE SPRING LOADED POPPETS COULD EJECT, AND CAUSE EYE INJURY.**

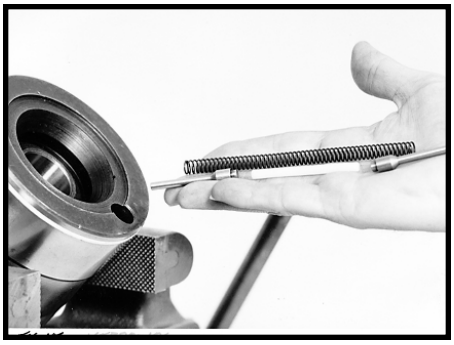


Figure 106

**install poppet assembly**

4. If the poppets were removed, position rack piston (29) in a soft jawed vise and install one poppet seat (31). SEE FIGURE 105. From the other end of the rack piston install one poppet (32), the spring (34), the nylon spacer rod (33), the other poppet (32), and the other poppet seat (31). Torque both poppet seats to 20-25 ft. lbs. (27-34 N m). Install both retaining rings (30). SEE FIGURES 106, 107.

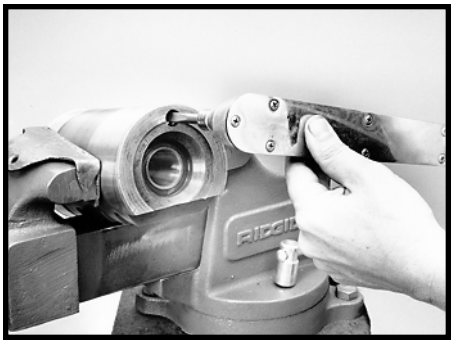


Figure 107

**install worm shaft/input shaft into rack piston**

5. When the 10 minute compression time has elapsed, remove the compression tool from the worm shaft/input shaft assembly (16). Grease the worm shaft seal ring (18) and the sealing surface inside the rack piston (29). Install the worm shaft/input shaft assembly into the rack piston end that will position the worm seal ring in the rack bore and the worm ball track grooves to accept the set of balls through the rack piston ball guide holes. SEE FIGURE 108.

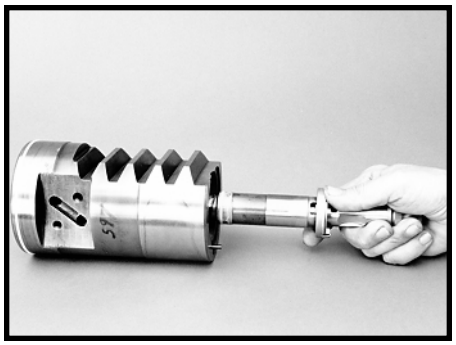


Figure 108

**CAUTION**

**CAUTION: Steps 6-11 describe the installation of the rack piston balls, guides, and caps or clips. Read through each step carefully to determine which ones you should follow.**

**NOTE**

**NOTE: If your ball return guides do not have a hole in the top for loading balls, then proceed to step 8. If your ball return guides do have a hole in the top, then follow steps 6 & 7. SEE FIGURE 77 Page 28.**

**assemble ball return guides**

6. Assemble the ball return guides (44) into the rack piston (29). Make sure that the ball return guides are seated.

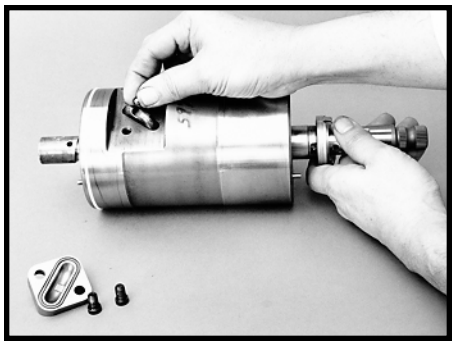


Figure 109

**WARNING**

**WARNING: DO NOT SEAT GUIDES WITH A HAMMER. DAMAGE TO GUIDES CAN RESULT IN SUBSEQUENT LOCK-UP OR LOSS OF STEERING.**

**assemble balls**

7. Assemble 34 balls (43) into the ball return guides (44) and rack piston (29). Drop the balls through the hole provided in the ball return guides. As you drop the balls, rotate the worm shaft/input shaft (16) to pull the balls down into the grooves. SEE FIGURE 109. Read warning, then go to step 10.

**WARNING**

**WARNING: MAKE SURE THE BALL RETURN GUIDES STAY DOWN IN PLACE WHILE YOU ASSEMBLE THE BALLS. FAILURE TO HOLD THE GUIDES DOWN MAY RESULT IN A BALL BEING TRAPPED OUTSIDE THE CLOSED LOOP. A TRAPPED BALL CAN RESULT IN A STEERING LOCKUP, WHICH COULD CAUSE AN ACCIDENT.**

**assemble balls**

8. For ball return guides which do not have the hole in top, follow this procedure. Insert the eraser end of a pencil into one ball return guide hole of the rack piston as far as it will go. Drop 22 balls (of the 34 total) into the other ball return guide hole of the rack piston. SEE FIGURE 110. Turn the worm shaft/input shaft (16) to advance the balls toward the other hole. You will feel resistance at the pencil after you drop the 22nd ball. At this time, a ball will be visible at the base of each hole. Remove the pencil.

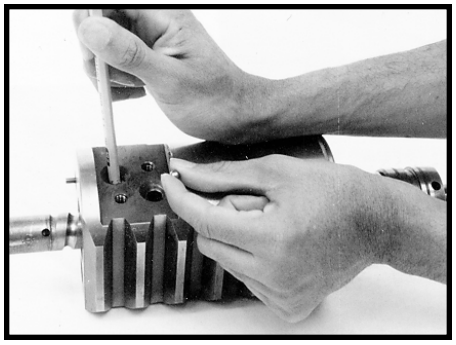


Figure 110

**WARNING**

**WARNING: DO NOT TURN THE WORM SHAFT OR ALLOW THE RACK PISTON TO MOVE AFTER YOU REMOVE THE PENCIL. IF THE WORM SHAFT OR RACK PISTON MOVE BEFORE BALL RETURN GUIDES ARE IN PLACE, A BALL MAY MOVE INTO THE DEAD TRACK BEYOND THE BALL RETURN GUIDES. THIS CAN RESULT IN A STEERING LOCKUP, WHICH COULD CAUSE AN ACCIDENT.**

Figure 111

**install ball return guide halves**

9. Coat the ball return guides (44) liberally with grease and insert the remaining 12 balls into a guide half. SEE FIGURES 111, 112. Join the guide halves together and install this subassembly into the rack piston.

Figure 112

**NOTE**

**NOTE: For models with the ball return clip (46A) per form step 10. SEE FIGURE 72. For models with the ball return guide cap (46) perform step 11. SEE FIGURE 74.**

**assemble ball return guide clip**

10. If your gear is equipped with the ball return guide clip (46A), install it so that both bolt hole faces are in full contact with the rack piston (29) surface. Install the two lock tabs (47A) and the two hexagon head bolts (47B) Torque the bolts to 14-22 ft. lbs. (19-30 N m). Finish by bending up the lock tabs against the bolt heads. SEE FIGURES 113, 114. 1/2 inch socket required.

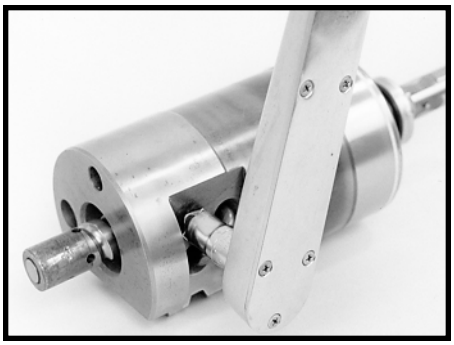


Figure 113

**NOTE**

**NOTE: The current ball return guide clip (46A/47A) will have integral lock tabs and be included in current service seal kits.**

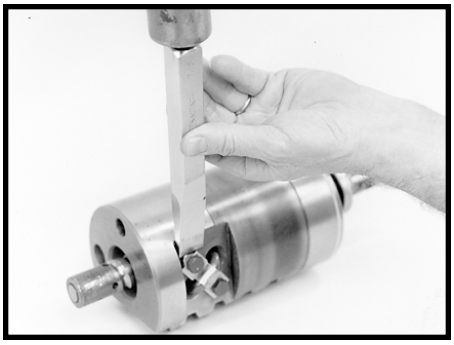


Figure 114

**assemble ball return guide cap**

11. If your gear is equipped with the ball return guide cap (46), instead of the clip, grease the new ball return guide cap seal (45) and place it in the seal groove of the cap. Assemble the cap so that the seal makes full contact with the rack piston surface. SEE FIGURE 115. Install the two new Allen head or Torx head screws (47) and torque them to 14-22 ft. lbs. (19-30 N m). A 5/32 inch Allen socket or a T-30 Torx socket required. SEE FIGURE 116.

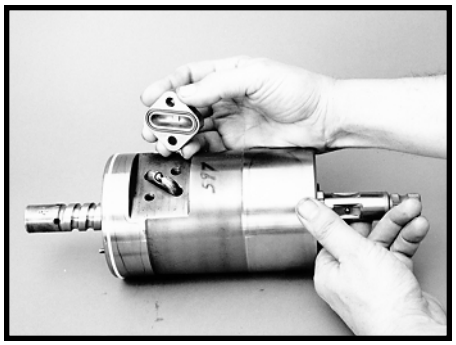


Figure 115

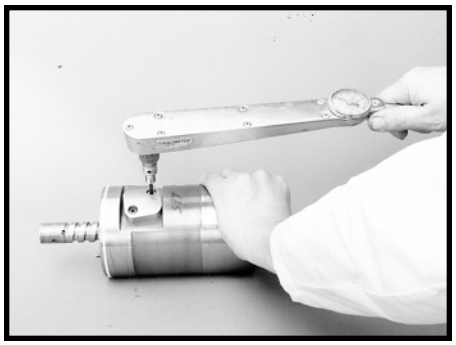


Figure 116

**WARNING**

**WARNING: ROTATE THE WORM SHAFT FROM END OF TRAVEL TO END OF TRAVEL, TO MAKE CERTAIN THAT YOU HAVE INSTALLED THE BALLS PROPERLY. IF YOU CANNOT ROTATE THE SHAFT, YOU WILL HAVE TO REMOVE THE BALLS AND REASSEMBLE THEM. IF YOU INSTALL THE GEAR ON A TRUCK WITH THE SHAFT UNABLE TO ROTATE, THE GEAR WILL NOT FUNCTION.**

**install rack piston worm shaft assembly into housing**

12. Position the housing (19) securely in a vise as it was for the disassembly procedures. SEE FIGURE 40 page 20. Apply a generous amount of clean grease to the Teflon rack piston seal (36) and to the housing cylinder bore. SEE FIGURE 117. Install the rack piston (29) worm shaft/input shaft (16) assembly into the long end of the housing so that the Teflon rack piston seal goes in last. SEE FIGURE 118.

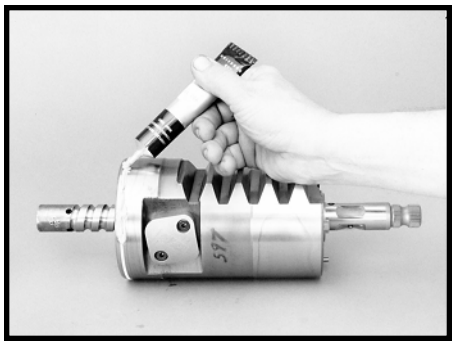


Figure 117

**CAUTION**

**CAUTION: Be certain that the seal enters the long end last; otherwise, a large section of the seal will be cut and the vehicle will have no power steering assist.**

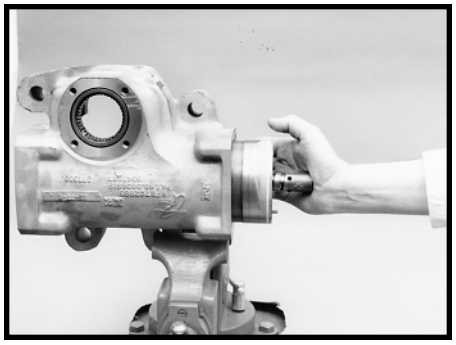


Figure 118

**NOTE**

**NOTE: To ease the later assembly of the sector shaft (48), rotate the rack piston worm shaft assembly in the housing so that the rack piston teeth are exposed in the sector shaft cavity of the housing.**

**assemble worm shaft, poppet adjusting screws & sealing nuts**

13. If disassembled, assemble a new worm shaft/input shaft adjusting screw sealing nut (39) onto the solid (nonslotted) end of the worm shaft preload adjusting screw (38), so that the seal on the sealing nut will face the end cover (37). Assemble one NEW poppet valve adjusting screw sealing nut (2) onto the poppet valve adjusting screw (42) and assemble the other NEW poppet valve adjusting. screw sealing nut (2) onto the other poppet valve adjusting screw (3) in the same manner as described for parts (39) and (38).

**assemble poppet screw assembly into end cover**

14. Assemble poppet adjusting screw (42) and nut (2) assembly into end cover (37) a few turns. Final adjustments will be made later.

**NOTE**

**NOTE: The poppet valve adjusting screws may or may not be of the same length. If not the same length, assemble the shorter adjusting screw (42), 2.25 in. (57 mm) long, into the end cover (37).**

**WARNING**

**WARNING: IF THE SCREWS ARE OF UNEQUAL LENGTH, YOU MUST INSTALL THE SHORTER SCREW INTO END COVER. OTHERWISE, THE POPPET ASSEMBLY MAY BREAK AND CAUSE THE STEERING GEAR TO LOCKUP, POSSIBLY RESULTING IN AN ACCIDENT.**

**install worm shaft preload adjusting screw**

15. Assemble the worm shaft preload adjusting screw (38) and nut (39) assembly into the end cover (37) a few turns. Final adjustments will be made later. A slot screw driver or 5/16 inch Allen wrench socket required.

**install end cover seal ring**

16. Apply clean grease to the end cover seal ring groove on the end cover (37). Install the new end cover seal ring (9) into the end cover seal ring groove. SEE FIGURE 119.

**NOTE**

**NOTE: When installed, the end cover seal ring should extend slightly above the machined surface of the end cover.**

**CAUTION**

**CAUTION: When performing step 17, make sure that the rack piston (29) teeth are fully visible in the sector shaft cavity of the housing. This is necessary to insure proper location of the poppets, and to insure that the poppet adjusting screw will contact the poppets.**

**install end cover**

17. Position the end cover (37) so that the poppet adjusting screw (42) is aligned with the end of the poppet (32). SEE FIGURE 120.

**install end cover bolts**

18. Install the four end cover bolts (41), 1.625 in. (41 mm) long, and washers (40), and torque the bolts to 150-170 ft. lbs. (203-230 N m) if dry, or 108-128 ft. lbs. (146-174 N m) if lubricated. A 13/16 inch socket required. SEE FIGURE 121.

**install valve sleeve rings & seals**

19. Grease the two new backup O-rings (13) and the two new Teflon seal rings (12). Using seal installation tool J26741, assemble the backup O-rings and then the Teflon seal rings onto the valve sleeve (14). SEE FIGURES 122, 123.

**NOTE**

**NOTE: Assemble each O ring and seal ring from the end closest to its groove.**

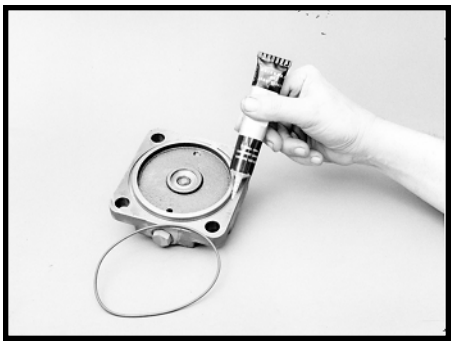


Figure 119

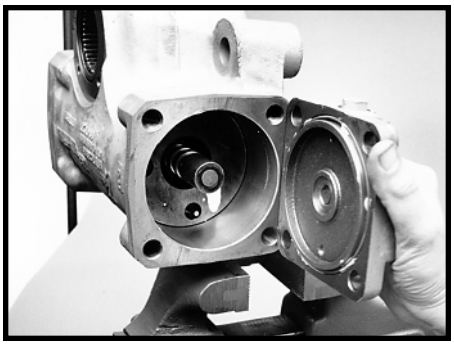


Figure 120

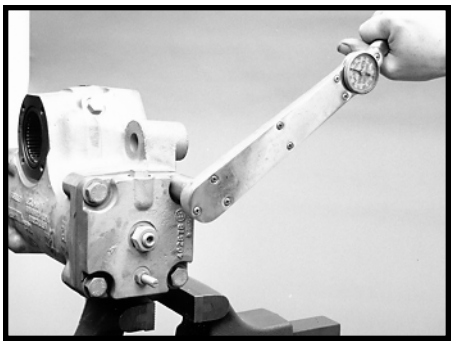


Figure 121

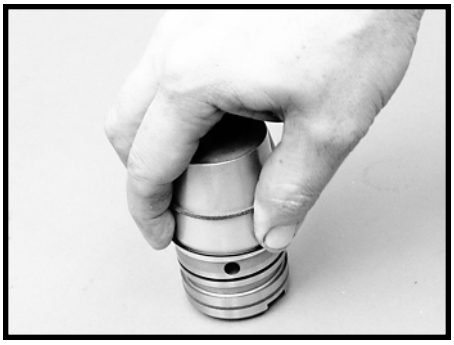


Figure 122

Figure 123

**compress rings**

20. Use compression tool J26742 to compress the Teflon seal rings. SEE FIGURE 124. Leave the compression tool on for 10 minutes.

**CAUTION**

**CAUTION: A minimum of ten minutes with the compression tool in place is required to ensure that the seal rings are properly seated. Otherwise, the valve sleeve will be difficult to assemble into the valve housing, and the seal rings may be damaged during installation.**

Figure 124

**assemble poppet adjusting screw**

21. Assemble the poppet valve adjusting screw (3) and nut (2) assembly into the valve housing (8) 4 or 5 turns. Final adjustments will be made later. Be sure you have the correct length adjusting screw.

**install valve housing seal ring**

22. Apply clean grease to the valve housing (8) seal ring groove. Install a new valve housing seal ring (9) into valve housing seal ring groove. SEE FIGURE 125.

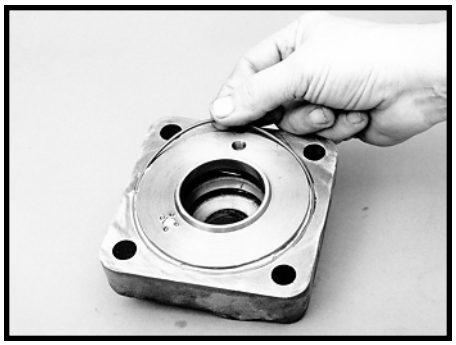


Figure 125

**NOTE**

**NOTE: When installed, the valve housing seal ring should extend slightly above the machined surface of the valve housing.**

**install thrust washer**

23. Apply a generous amount of clean grease to one thrust washer (10). Install the thrust washer into the valve housing (8), making sure to center the washer. SEE FIGURE 126.

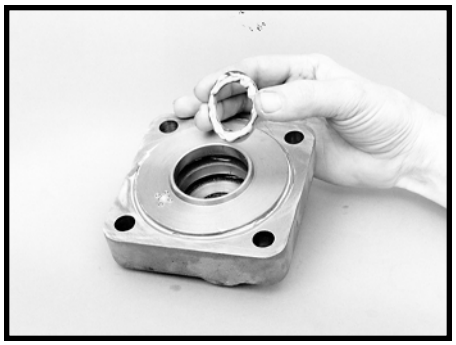


Figure 126

**install thrust bearing**

24. Apply a generous amount of clean grease to the thrust bearing (11). Install the thrust bearing into the valve housing (onto the thrust washer), making sure to center the bearing on the washer. SEE FIGURE 127.

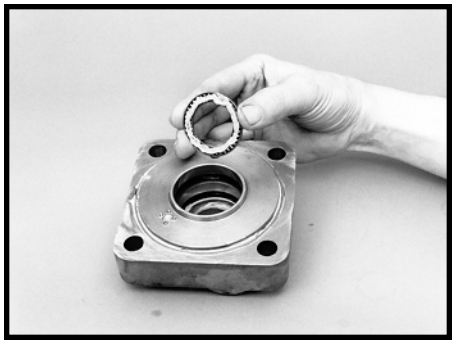


Figure 127

**WARNING**

**WARNING: THE THRUST WASHER AND THRUST BEARING MUST BE FLAT AND CENTERED IN THE COUNTERBORE SURFACE, OTHERWISE, THE THRUST WASHER COULD BREAK WHEN YOU ASSEMBLE THE VALVE HOUSING INTO THE GEAR HOUSING (19). SEE FIGURE 128. A BROKEN WASHER COULD CAUSE UNCONTROLLABLE STEERING, POSSIBLY RESULTING IN AN ACCIDENT.**

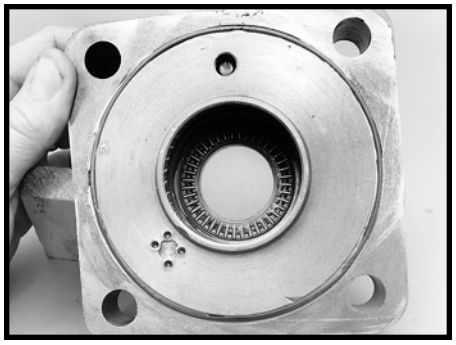


Figure 128

**install thrust washer**

25. When the 10 minute compression time has elapsed, remove the compression tool J26742 from the valve sleeve (14). Apply more grease to the valve sleeve seals, and grease the thrust washer face on the end of the valve sleeve without the drive slots. Place the other thrust washer (10) onto the valve sleeve end without the drive slots. SEE FIGURE 129.

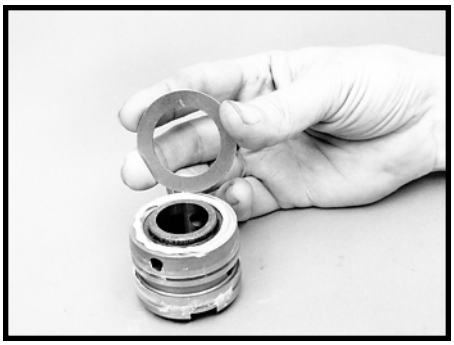


Figure 129

**WARNING**

**WARNING: THIS THRUST WASHER MUST BE SECURELY IN PLACE ON THE VALVE SLEEVE. IF IT IS NOT, IT CAN BREAK AND CAUSE UNCONTROLLABLE STEERING, POSSIBLY RESULTING IN AN ACCIDENT.**

**assemble valve sleeve onto valve housing**

26. Assemble the valve sleeve (14) with attached thrust washer down, into the valve housing (8). SEE FIGURE 130. When the valve sleeve is in place, it should measure between .370 and .400 inches (9.40-10.16 mm) above the face of the valve housing to the end of the valve sleeve nose. SEE FIGURE 131.

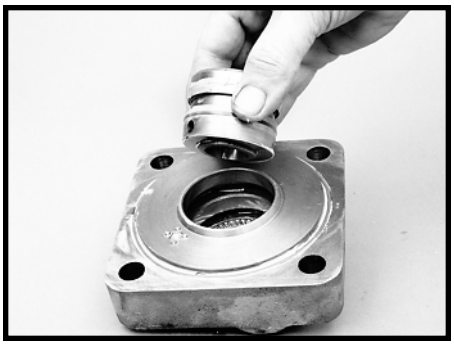


Figure 130

**WARNING**

**WARNING: DO NOT FORCE VALVE SLEEVE DOWN INTO THE VALVE HOUSING. MAKE SURE VALVE SLEEVE SEAL RINGS ARE COMPRESSED. MISASSEMBLY OR INCORRECT MEASUREMENT MAY CAUSE THE THRUST WASHERS OR THRUST BEARING TO BREAK DURING GEAR OPERATION, WHICH WILL RESULT IN UNCONTROLLABLE STEERING.**

**position rack piston & rotate worm shaft**

27. Position the rack piston (29) so that it is flush with the open end of the gear housing (19). Rotate the worm shaft (16) until it extends out of the rack piston as far as it will go.

**WARNING**

**WARNING: WORM SHAFT AND VALVE SLEEVE UNITS ARE ASSEMBLED AND SOLD AS MATCHED SETS. USE ONLY PREMATCHED SETS FOR REPLACEMENT. NEVER MATE AN OLD SLEEVE WITH A NEW WORM OR AN OLD WORM WITH A NEW SLEEVE. TO DO SO MAY DAMAGE THE GEAR OR INJURE THE DRIVER, OR DO BOTH DURING OPERATION.**

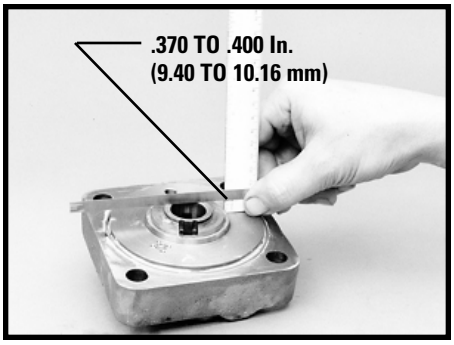



Figure 131

**install valve assembly onto worm shaft/input shaft assembly**

28. Locate the timing mark on the valve sleeve (14), a faint, punched mark on the chamfered edge of the valve sleeve or an indented mark on the front face, of the sleeve. SEE FIGURE 132. Locate the scribed timing mark on the worm shaft. SEE FIGURE 62, page 25. Next, grasp the valve housing/ valve sleeve assembly with your thumbs on the valve housing face and your fingers applying pressure to keep the valve sleeve in the valve housing. SEE FIGURE 133. Align the previously located timing marks and place the valve housing/valve sleeve assembly onto the input shaft end of the worm shaft/ input shaft (16) until the drive lugs are fully engaged in the valve sleeve slots. SEE FIGURE 134.

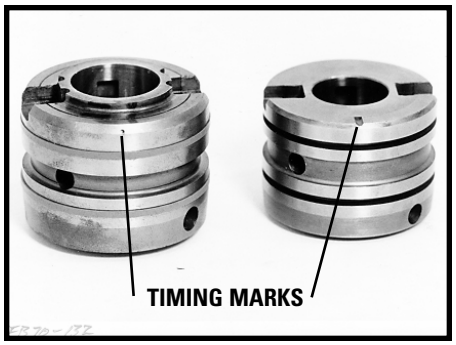


Figure 132

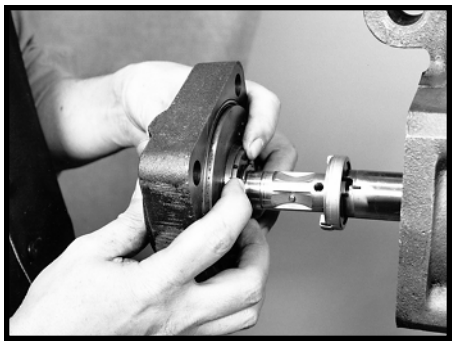


Figure 133

**NOTE**

**NOTE: Valve sleeves are identified and matched to a right or left hand lead of the worm screw. If the screw has a right hand thread (that is, goes into the rack piston when turned clockwise), the valve sleeve will have the letter "R" stamped between the seal lands. For a left hand worm lead (which will come out of the rack piston when turned clockwise) the mating valve sleeve has no identifying letter or has the letter "L" stamped between the seal lands.**

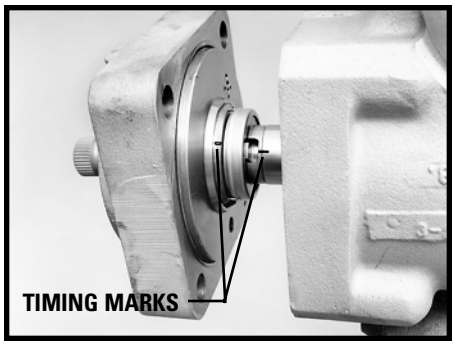


Figure 134

**WARNING**

**WARNING: IF YOU PLACE AN INCORRECT VALVE SLEEVE ON A WORM AND ASSEMBLE THIS INTO THE GEAR, THE GEAR WILL NOT FUNCTION PROPERLY. INSTEAD, THE MECHANISM WILL JERK THE STEERING WHEEL WITH SUCH FORCE, THAT IT COULD INJURE THE DRIVER.**

**finish valve housing installation**

29. Maintain pressure on the valve end of the valve housing (8) to insure continued engagement of the drive lugs and thrust bearing package. SEE FIGURE 135. While maintaining pressure, rotate the valve housing to align the poppet adjusting screw (3) with the poppet (32) in the rack piston (29). Continue pressure, and rotate the input shaft to bring the valve housing into contact with the gear housing face.

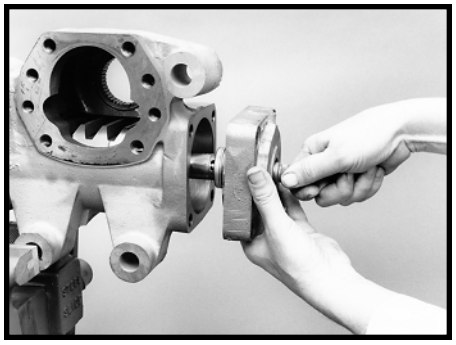


Figure 135

**install valve housing bolts**

30. Assemble four valve housing bolts (1), 2.125 in. (53.98 mm) long, into the housing (19) and torque to 150-170 ft. lbs. (203-230 N m) if dry or 108-128 ft. lbs. (146-174 N m) if lubricated. A 13/16 inch socket required. SEE FIGURE 136.

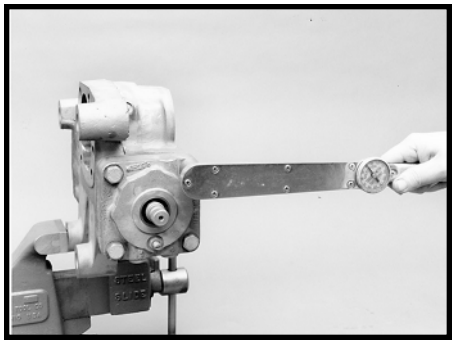


Figure 136

**assemble adjusting screw** and retainer

31. If the adjusting screw (49) has been removed from the sector shaft (48), clamp the sector shaft into a soft-faced vise by gripping the serrated end. Coat the expanded end of the new

adjusting screw with a suitable grade of wheel bearing grease and insert into recess in end of sector shaft. Thread a new sector shaft screw retainer (50) into the sector shaft and adjust to permit free rotation of sector shaft adjusting screw by hand without perceptible end play [.000 to .002 in. (.05 mm) loose]. Stake the new retainer into the two slots provided using a suitable punch and again check freedom of adjusting screw movement and end play. SEE FIGURE 137.

Figure 137

**WARNING**

**WARNING: USE CARE IN SECURELY STAKING THE RETAINER (50) INTO THE SECTOR SHAFT SLOTS. A RETAINER THAT IS BROKEN OR CRACKED DURING THE STAKING PROCEDURE MUST BE REPLACED AS IT COULD RESULT IN THE SECTOR SHAFT NOT BEING RETAINED AND THE LOSS OF MANUAL AND POWER STEERING CONTROL.**

**grease side bearing cover bearing**

32. Apply a generous amount of clean wheel grease (do not substitute another type of grease) to the bearing race or caged bearing assembly inside the side cover (56).

**CAUTION**

**CAUTION: Use only wheel bearing grease. This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use wheel bearing grease could result in premature bearing wear.**

**NOTE**

**NOTE: You will have 41 or 42 rolls to assemble into the side cover bearing; 41 rolls—BR-970; 42 rolls—BR-970-1. Do not these rolls for the side cover with the rolls for the trunnion cover side of the gear housing.**

**assemble side cover bearing**

33. If the side cover does not have a caged bearing assembly, assemble 41 or 42 rolls into the side cover bearing race. Grease must retain rolls. SEE FIGURE 138.

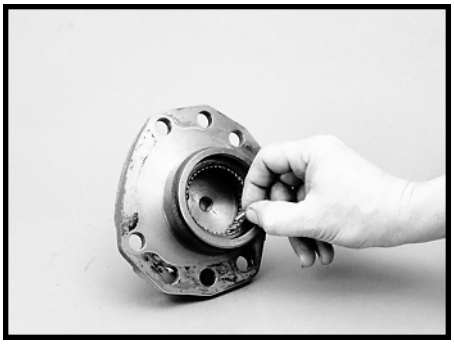


Figure 138

**NOTE**

**NOTE: If the service replacement Teflon backup washer (53) is not an integral part of the service replacement seal (52), see alternate service construction (52/53) on exploded assembly foldout page, examine the lead in chamfer or radius on the side cover (short) end of sector shaft (48) bearing diameter. SEE FIGURE 139. If rough edges can be felt by drawing a thumb nail across the lead in chamfer or radius on the end of sector shaft, skip procedures #34, #35, #36 and follow procedures #37, #38, #39.**

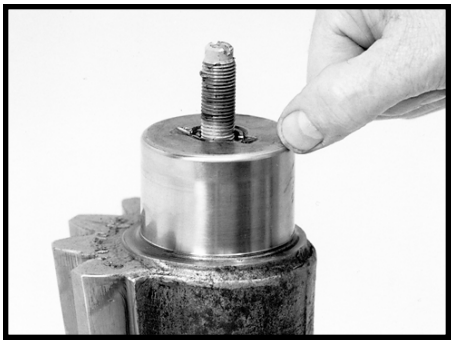


Figure 139

**CAUTION**

**CAUTION: Following procedures #34, #35, #36 with a sector shaft that does not pass the "thumb nail test," and a replacement seal (52) that does not have the Teflon washer (53) integral to it can result in the seal being destroyed when assembling sector shaft into side cover.**

**assemble side cover seal pack**

34. Assemble the steel back up washer (54) into side cover (56). Assemble a new Teflon washer (53) then a new two piece seal (52), or a new two piece seal that has the integral Teflon washer (52/53) into the side cover, such that the words "Oil side" are visible after the seal is assembled. SEE FIGURE 140.

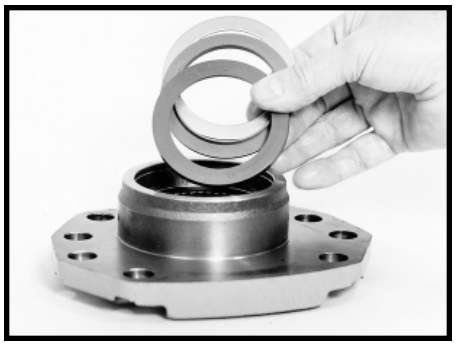


Figure 140

**CAUTION**

**CAUTION: Be sure that a separate Teflon washer (53) is not used with a two piece seal (52/53) that has the Teflon washer integral to it.**

**WARNING**

**WARNING: THE WORDS "OIL SIDE" MUST BE VISIBLE ON THE SEAL AFTER IT IS IN PLACE. IF NOT, THE SEAL WILL NOT FUNCTION, AND A LOSS OF POWER STEERING ASSIST MAY OCCUR.**

**assemble retaining ring**

35. Assemble retaining ring (51) into the ring groove in the side cover. SEE FIGURE 141

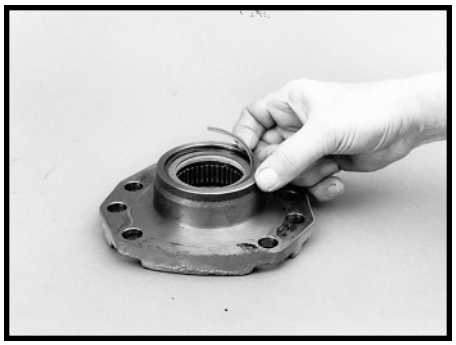


Figure 141

**install sector shaft into side**

36. Apply a generous amount of clean grease to the short bearing area of the sector shaft (48), and insert the sector shaft into the side cover (56). Screw the adjusting screw into the side cover until it reaches solid height. Then, back out the adjusting screw one turn, so that the side cover rotates freely on the sector shaft. SEE FIGURE 142.

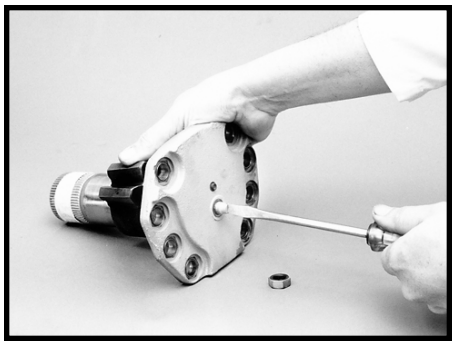


Figure 142

**CAUTION**

**CAUTION: Be sure that one or more bearing rolls do not become dislodged during assembly of sector shaft into side cover.**

**assemble steel & Teflon washers into side cover (alternate)**

37. If the replacement Teflon washer (53) is not an integral part of the two-piece seal (52) and the sector shaft (48) did not pass the "thumb nail test," assemble the steel backup washer (54) and then the Teflon washer (53) into the side cover (56) bearing bore. SEE FIGURE 143.

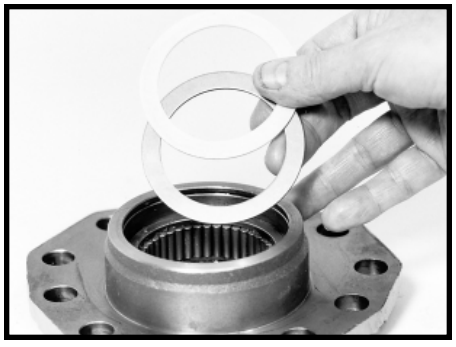


Figure 143 - ALTERNATE

**assemble retaining ring and seal (alternate)**

38. Assemble retaining ring (51) onto the side cover end of sector shaft (48). Assemble the two- piece seal (52) onto the end of the sector shaft about 1 inch (25.4 mm). The words "oil side" on the seal must face toward the sector shaft. SEE FIGURE 144.

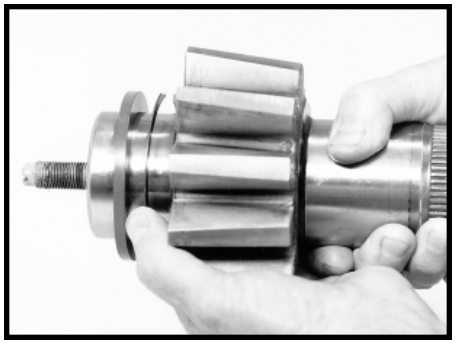


Figure 144 - ALTERNATE

**CAUTION**

**CAUTION: Be sure the two piece seal and the side cover bearing rolls remain correctly assembled and that the vent plug (57) has been removed during these procedures.**

**install sector shaft into side cover (alternate)**

39. Be sure the side cover bearing, the sector shaft bearing diameter and seal are well greased, then insert sector shaft (48) assembly into the side cover (56) bearing only until the shaft will retain the loose side cover bearing rolls in place (about 8 turns of adjusting screw) Slowly and carefully work the two piece seal (52) down the sector shaft and squarely into the side cover until it is past the retaining ring groove. Then work the retaining ring (51) into the retaining ring groove. Use an appropriate blunt end punch or punches. SEE FIGURE 145. Carefully turn the adjusting screw (49) through side cover until it reaches solid height then back screw one turn, so that the side cover rotates freely on sector shaft.

Figure 145 - ALTERNATE

**assemble vent plug**

40. Assemble the vent plug (57) into the hole provided on the side cover (56). Press the vent plug in flush with the side cover. SEE FIGURE 146.

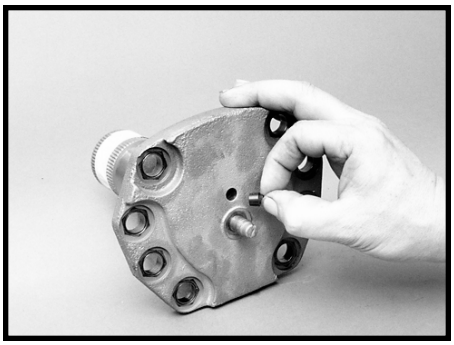


Figure 146

**WARNING**

**WARNING: DO NOT WELD OR OTHERWISE PLUG THIS HOLE IN ANY PERMANENT MANNER. THIS IS A SAFETY VENT WHICH FUNCTIONS ONLY IF THE SIDE COVER SEAL FAILS. IF THE SEAL FAILS AND THE PLUG CANNOT VENT, THE STEERING GEAR MAY LOCKUP OR OTHERWISE MALFUNCTION.**

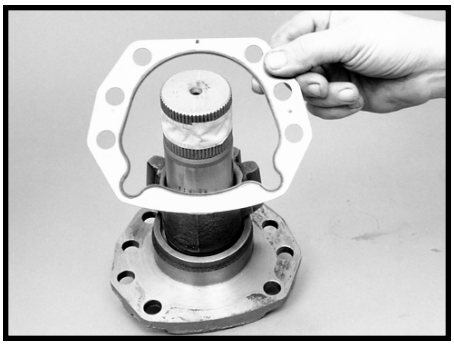


Figure 147

**assemble jam nut**

41. Assemble the jam nut (58) onto the adjusting screw (49) a few threads. Final adjustment will be made later.

**install side cover gasket**

42. Apply clean grease to the new side cover gasket (55), and assemble it onto the side cover (56) There must be enough grease to hold the gasket in place. SEE FIGURE 147.

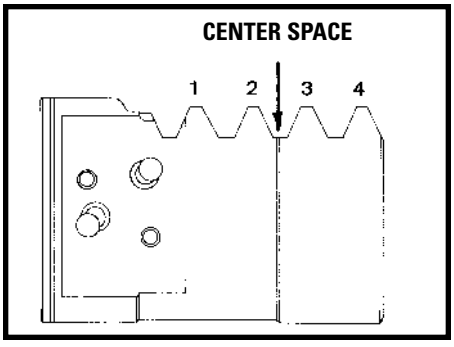



Figure 148

**center rack piston**

43 There are four teeth on the rack piston (29) SEE FIGURE 148. Position the tooth space between the second and third teeth in the center of the housing sector shaft cavity. SEE FIGURE 149. This will center the rack piston in the cavity.

**CAUTION**

**CAUTION: If the rack piston is not centered when sector shaft is installed, the gear travel will be severely limited in one direction of travel, and significant internal damage to the steering gear can occur when the gear is operated.**

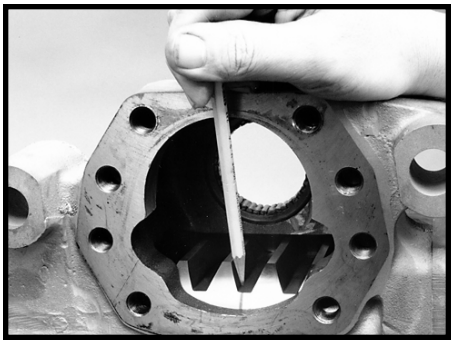


Figure 149

**make initial worm preload adjustment**

44. With the rack piston (29) in its center position, torque the worm shaft/input shaft adjusting screw (38) using a 5/16 inch Allen wrench socket into solid height (15 to 20 ft. lbs. [20.3 to 27.1 N m]). Then loosen the adjusting screw 1/4 to 1/2 turn and note torque required to rotate worm shaft/ input shaft (16) through 90° each side of center, using an 12 point socket that will fit input shaft serrations and an appropriate torque wrench. SEE FIGURE 150. Loosen adjusting screw if noted input shaft torque exceeds 15 in. lbs. (17 N m). Return rack piston to center position.

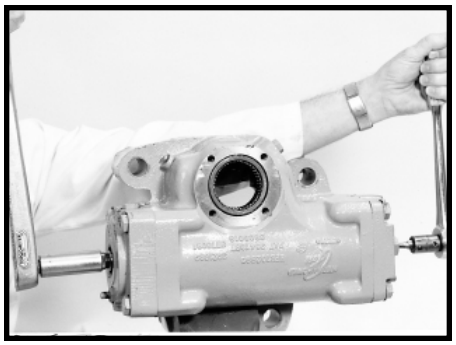


Figure 150

**WARNING**

**WARNING: AS YOU PLACE THE SECTOR SHAFT THROUGH THE HOUSING BEARING (20), BE CAREFUL NOT TO KNOCK OUT ANY OF THE BEARING ROLLS. SEE FIGURE 151. BE CAREFUL ALSO NOT TO PINCH THE SIDE COVER GASKET (55). SHOULD THE BEARING ROLLS BE KNOCKED OUT, OR THE SIDE COVER GASKET PINCHED, PREMATURE BEARING AND SEAL FAILURE MAY OCCUR, WHICH COULD RESULT IN A LOSS OF POWER STEERING ASSIST.**

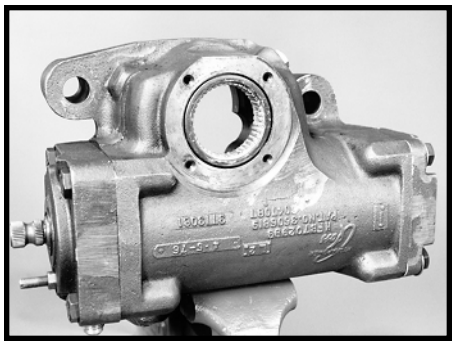


Figure 151

**install sector shaft/side cover into housing**

45. Clean off any old tape on the sector shaft (48) serrations. Retape the serrations and bolt groove with one layer of tape. Assemble the sector shaft (48) side cover (56) assembly into the gear housing (19), with the center tooth of the sector shaft engaging the tooth space between the second and third teeth on the rack piston. SEE FIGURE 152.

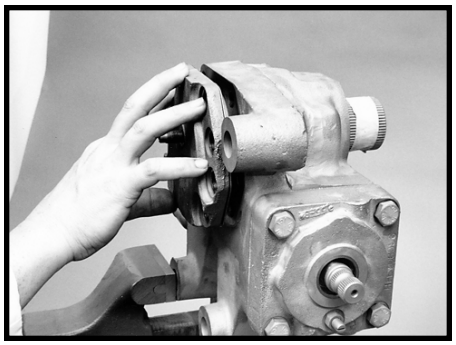


Figure 152

**install side cover bolts**

46. Assemble the eight special ring head bolts (59) and torque them to 150-170 ft Lbs. (203-230 N m) if dry or 108-125 ft. lbs. (146-174 N m) if lubricated. 13/16 inch socket required.

**assemble trunnion cover seal pack**

47. Place the trunnion cover (25) on a bench to install the new seal package. Start with the Teflon backup washer (24).

**assemble seal**

48. Assemble the two-piece sector shaft seal (23) so that the words “oil side” are visible. SEE FIGURE 153.

**WARNING**

**WARNING: THE WORDS “OIL SIDE” MUST BE VISIBLE. IF NOT, THE SEAL WILL NOT FUNCTION AND A LOSS OF POWER STEERING ASSIST MAY OCCUR.**

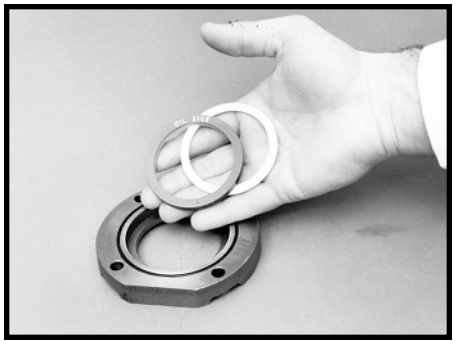


Figure 153

**install trunnion cover seal ring**

49. Grease the new trunnion cover seal ring (22) and install it into the trunnion cover seal ring groove.

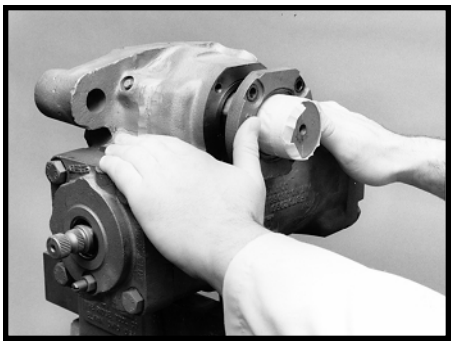


Figure 154

**install trunnion cover, bolts, washers & seal**

50. Before installing the trunnion cover (25) and seal assembly onto the housing (19), visually inspect the housing bearing (20) to insure that all bearing rolls are properly in place. Then, install the trunnion cover. SEE FIGURE 154. Install four trunnion cover bolts (28) and washers (27) and torque the bolts to 15-22 ft. lbs. (20-30 N m) if dry or 11-16 ft. lbs. (15-22 N m) if lubricated. SEE FIGURE 155. A 1/2 inch socket required. Pack clean high temperature industrial grease per Ross specification 045231. * Mobil Temp 1 or 2 grease or equivalent around the seal area of sector shaft (48). Install a new dirt and water seal (26) using a suitable blunt end drift.

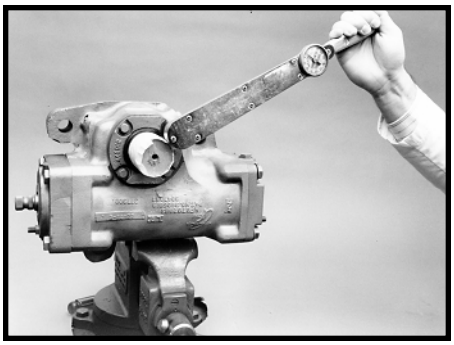


Figure 155

**assemble seal protector boot & grease fitting**

51. Apply more of the special grease around the seal area of sector shaft and to the new protector boot (60) in the area inside of the smaller diameter ring. Assemble the protector boot onto the sector shaft and trunnion cover. Locate the boot grease fitting hole toward the input shaft end of gear assembly. SEE FIGURE 156. Insert grease fitting (61) into protector boot.

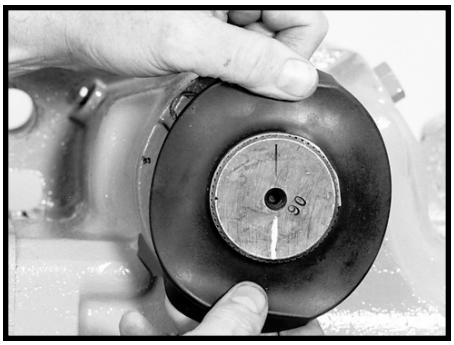


Figure 156

**install input shaft seal pack**

52. Apply clean grease in the input shaft seal assembly (7), washer (6) and to the input shaft. Install the new two-piece input shaft seal (7) flat side out and the steel backup washer (6), using seal driving tool J28490. Install the retaining ring (5). SEE FIGURES 157, 158.

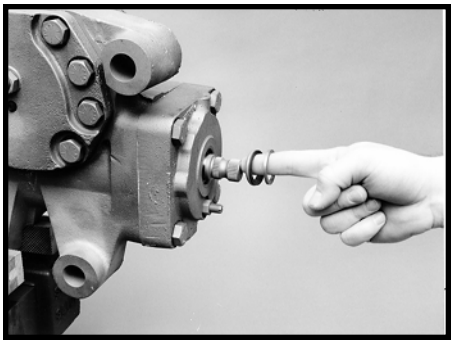


Figure 157

**pack with grease and install dirt and water seal**

53. Pack the area around the input shaft with high temperature industrial grease per Ross specification 045231, Mobil Temp 1 or 2 or equivalent, and install the dirt and water seal (4), using seal driving tool J28490 or suitable blunt ended drift.

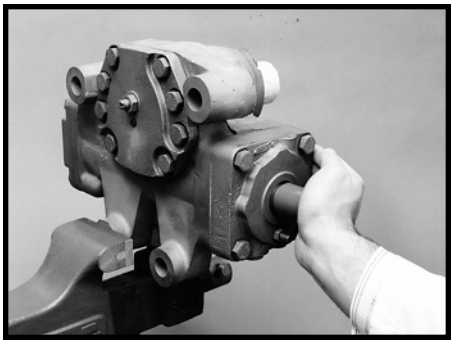


Figure 158

*Mobil Temp is a Registered Trademark of Mobil Oil Co.

**assemble seal protector**

54. Apply more of the special grease to the cupped side of the new seal protector (62) and assemble it, cupped side in on to the worm shaft/input shaft (16) and into the serration relief groove. SEE FIGURE 159.

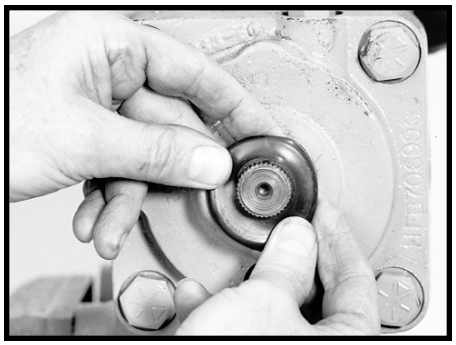


Figure 159

**install manual bleed screw, if equipped**

55. If your gear is equipped with the manual bleed screw (I9A), install it into the gear housing (19) and torque it to 27-33 in. lbs. (3.1-3.7 N m). SEE FIGURE 160. 5/16 inch hex socket required.

Figure 160

This completes assembly of the HFB70 steering gear. Before you install the gear onto the vehicle, make final adjustments described on next page. All ports should be plugged until unit is installed on vehicle.

# Final Adjustment

**center steering gear**

1. To center the steering gear, rotate worm shaft/input shaft (16) until the timing mark on the end of sector shaft (48) is perpendicular to the worm shaft/input shaft. SEE FIGURE 161. A 12 point box end or socket wrench required.

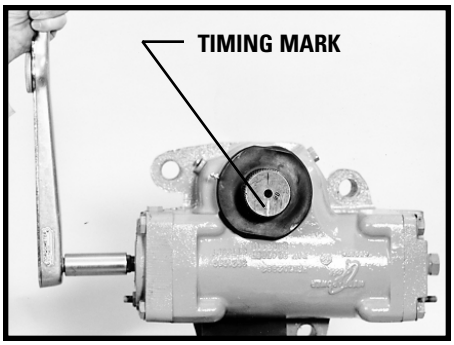


Figure 161

**NOTE**

**NOTE: Initial worm preload adjustment was accomplished in assembly procedure 44, page 46, before assembly of sector shaft (48).**

**tighten adjusting screw**

2. Tighten sector shaft adjusting screw (49) to provide 25 to 30 in.lbs. (2.8 to 3.4 N m) of torque required to rotate the worm shaft/input shaft (16) through 180° each side of center. SEE FIGURE 162

**NOTE**

**NOTE: This procedure will properly mesh and seat the rack piston teeth and sector shaft teeth for final adjustments.**

**loosen adjusting screw and note torque**

3. Loosen sector shaft adjusting screw (49) one turn and note maximum torque required to rotate the worm shaft/input shaft (16) through 180° each side of center.

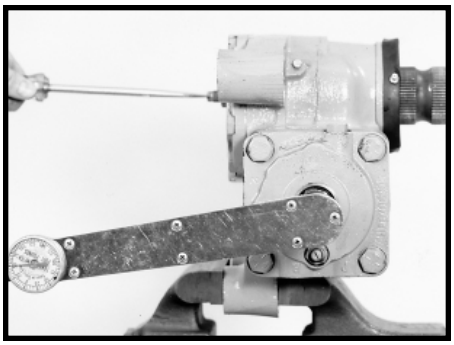


Figure 162

**adjust adjusting screw**

4. Adjust sector shaft adjusting screw (49) to increase maximum torque noted in procedure #3 by 2 to 4 in. lbs. (.23 to .45 N m). Torque jam nut (58) using a 3/4 inch socket, to 40 to 45 ft. lbs. (54 to 61 N m) and check worm shaft/input shaft torque again. Re-adjust if worm shaft/input shaft torque exceeds 20 in. lbs. (2.3 N m).

**adjust worm shaft/input shaft adjusting screw**

5. Adjust worm shaft/input shaft adjusting screw (38), a 5/16 inch Allen wrench or screwdriver required, to increase maximum worm shaft/ input shaft (16) torque noted in procedure #4 by 10 to 15 in. lbs. (1.1 to 1.7 N m). Torque sealing nut (39) to 70-80 ft. lbs. (95-108 N m) using a 1-1/16 inch socket and check worm shaft/ input shaft torque again. Readjust if worm shaft/ input shaft torque exceeds 35 in. lbs. (4.0 N m). SEE FIGURE 163.

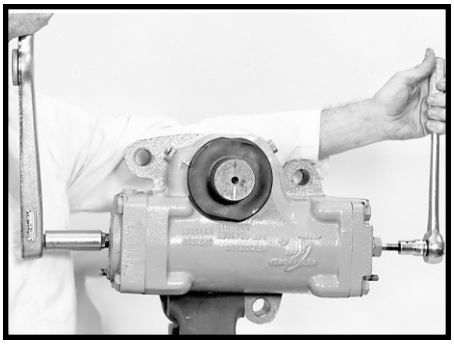


Figure 163

This completes the final adjustments of the HFB70 gear to be made before it is installed into the vehicle's steering system. Install the gear by following instructions in the vehicle shop manual. Then follow the succeeding sections of this service manual (HFB70) on "HYDRAULIC FLUID" and "FILLING AND AIR BLEEDING THE SYSTEM" which also includes instructions for adjustment of the optional adjustable poppet valve.

# Hydraulic Fluid

The steering system should be kept filled with one of the following fluids:

AUTOMATIC TRANSMISSION FLUID TYPE "E" or "F"
FORD SPEC. M2C138CJ
AUTOMATIC TRANSMISSION FLUID DEXRON 11
SHELL ROTELLA T.....SAE 30
MOBIL .....SAE 10W30
ASHLAND .....SAE 10W40
UNION.....SAE 10W40
TEXACO.....SAE 10W40
TEXACO.....SAE 15W40
MOBIL .....SAE 10W40
UNICAL GAURDOL .....SAE 15W40
UNICAL GAURDOL .....SAE 30
ESSOLUBE.....SAE 15W40
CHEVERON .....SAE 15W40
EMERY FRIGID-GO-OW-02 SYNTHETIC

**WARNING: COMPLETELY FLUSH THE STEERING SYSTEM WITH ONE OF THE RECOMMENDED FLUIDS ABOVE ONLY. DO NOT MIX OIL TYPES. ANY MIXTURE OR ANY UNAPPROVED OIL COULD LEAD TO SEAL DETERIORATION AND LEAKS. A LEAK COULD ULTIMATELY CAUSE THE LOSS OF FLUID, WHICH COULD RESULT IN A LOSS OF POWER STEERING ASSIST.**

# Filling and Air Bleeding the System

**CAUTION: For steps 1 and 2, do not turn the steering wheel. Otherwise, air may be induced into the system.**

1. Fill the reservoir nearly full. Crank the engine for 10 seconds without, if possible, allowing it to start. If the engine does start, shut it off immediately. Check and refill the reservoir. Repeat at least three times, each time checking and refilling the reservoir.

   **CAUTION: Do not allow the fluid to drop significantly or run out of the reservoir. This may induce air into the system.**

2. Start the engine and let it idle for 2 minutes. Shut the engine off and check the fluid level in the reservoir.

3. Start the engine again. Steer the vehicle from full left to full right turn several times. Add fluid, as necessary, to the fill line on the dipstick.

   **NOTE: Poppets, if equipped on the gear, must be adjusted so that they relieve pressure at full left and right turns to aid in the removing of air from the system. At this time, make sure any poppets are properly adjusted. If they are not, adjust them in accordance with section 4 (page 18) and repeat step 3.**

The above procedures should remove all the air from the steering system, unless the gear is mounted in an inverted position and is equipped with the manual bleed screw (I9A). SEE FIGURE 160, Page 48. If this is so, refer to step 4.

4. Remove the air from a gear mounted in an inverted position and equipped with a manual bleed screw (I9A) by following steps 1, 2 and 3 above. Then, with the engine idling, steer the gear from full left turn to full right turn several times. With the steering gear in neutral (no steering action), loosen the manual bleed screw about one turn, allowing air and aerated fluid to "bleed out" around the bleed screw until only clear (non aerated) fluid is bleeding out then close the bleed screw. 5/16 inch socket required. Check and refill reservoir.

   Repeat this procedure 3 or 4 times starting with the steering maneuver with bleed screw closed, until only clear (non aerated) fluid is discharged when bleed screw is loosened. Torque the manual bleed screw to 27-33 in. lbs. (3.1-3.7 N m). Check and refill reservoir

   **CAUTION: Do not turn steering wheel with bleed screw loosened as this could induce air into the system.**

# Warnings for Proper Steering Gear Operation

**WARNING: DO NOT WELD, BRAZE, OR SOLDER ANY STEERING GEAR OR SYSTEM ARM COMPONENTS.**

**WARNING: MAXIMUM FLOW UNDER ANY CONDITIONS MUST NOT EXCEED 8 GPM (30 LITERS/MIN).**

**WARNING: MAXIMUM OPERATING PRESSURE MUST NOT EXCEED 2000 PSI (137.9 BAR).**

**WARNING: ALWAYS CAREFULLY INSPECT ANY STEERING COMPONENT WHICH HAS BEEN (OR IS SUSPECTED TO HAVE BEEN) SUBJECTED TO IMPACT. REPLACE ANY DAMAGED OR QUESTIONABLE COMPONENT.**

# Steering System Maintenance Tips

- Prevent internal bottoming of the steering gear. Carefully check axle stops to be sure that they meet the manufacturer's specifications. -Regularly check the fluid and the fluid level in the power steering reservoir.

- Keep tires inflated to correct pressure.

- Always use a puller, never a hammer or torch, to remove pitman arms.

- Investigate and immediately correct the cause of any play, rattle, or shimmy in any part of the steering linkage or steering mechanism.

- Remove the cause of steering column misalignment.

- Encourage all drivers to report any malfunctions or accidents that could have damaged steering components.

- Do not attempt to weld any broken steering component. Replace the component with original equipment only.

- Do not cold straighten, hot straighten, or bend any steering system component.

- Always clean off around the reservoir filler cap before you remove it. Prevent dirt or other foreign matter from entering the hydraulic systems. -Investigate and correct any external leaks, no matter how minor.

- Replace filters and pumps in compliance with specification.

- If extended stationary use of vehicle is developing excessive hydraulic fluid temperatures consult vehicle manufacturer for auxiliary cooling method.

- Maintain grease pack applied behind the input and output shaft's dirt and water seal and seal protector as a general maintenance procedure. Grease fitting provided in output shaft seal protector.

**TRW Automotive**
Commercial Steering Systems
800 Heath Street
Lafayette, IN 47904
Tel 765.423.5377
Fax 765.429.1868
http://www.trw.com/commercialsteering

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